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Stope Control, Dilution and Recovery

By CHARLES A. MITKE

Equipment of the Combined Metals' Concentrator

By H. D. KEISER

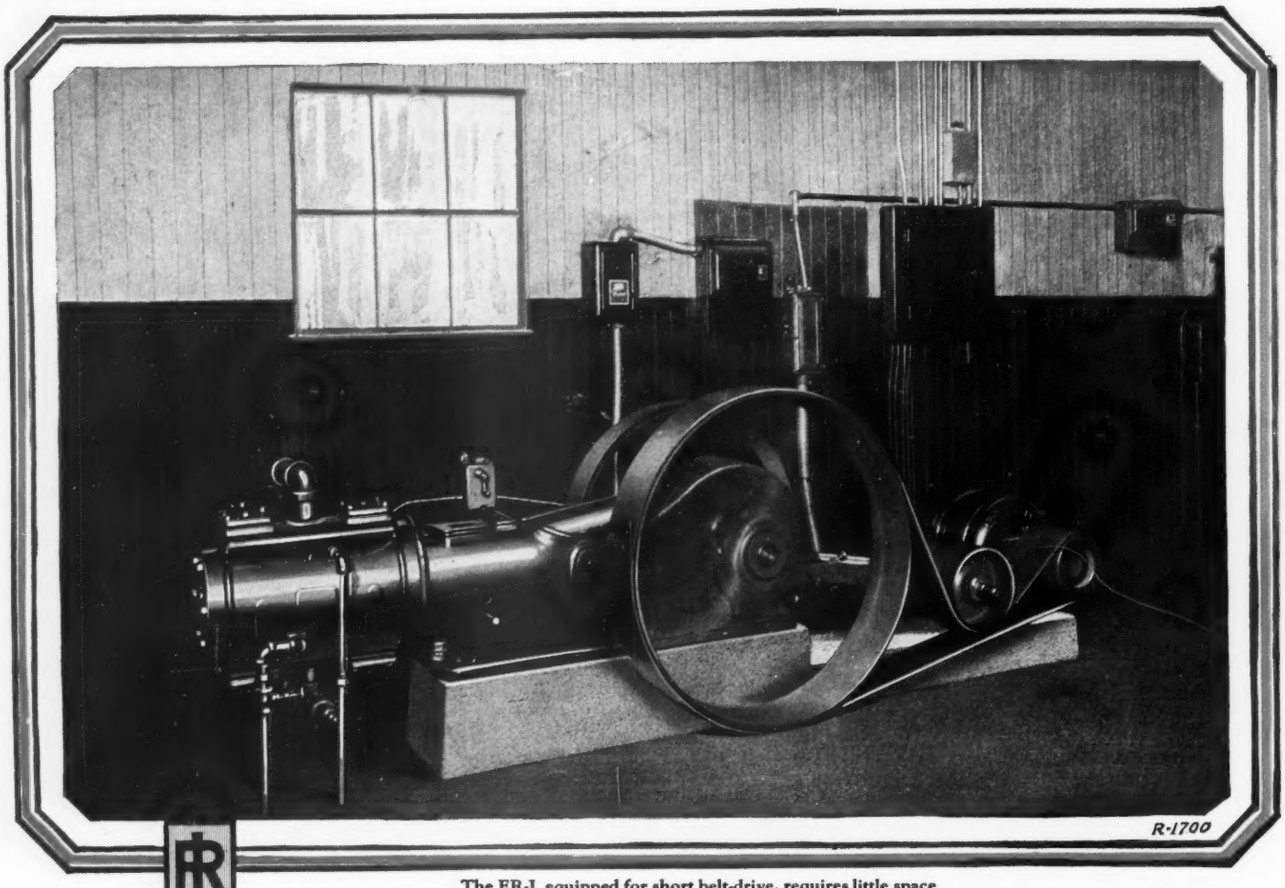
Graphic Analysis of Ore Settlements

By HOMAR L. JOHNSON

Impressions of Some Foreign Copper Mines

An Interview with C. B. Lakenan

By A. B. PARSONS



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Opportunity Offers For Invention In Modifying Old Processes As Well As In Developing New Ones

ROASTING with common salt was a preliminary feature of some of the older processes for the recovery of silver from refractory ores; but other methods, chiefly straight cyaniding, forced it into the discard. That principles sound in theory can be revived to advantage, by utilizing efficient equipment and by applying modern metallurgical ideas, has been proved at the Achotla unit of the Cia. Minera de Peñoles, State of Guerrero, Mexico. In a forthcoming issue Mr. E. R. Richards, head of the milling department, will present, in a scholarly monograph, complete details of the modified salt-roast process developed. The account will be found unusually interesting, informative, and inspiring.

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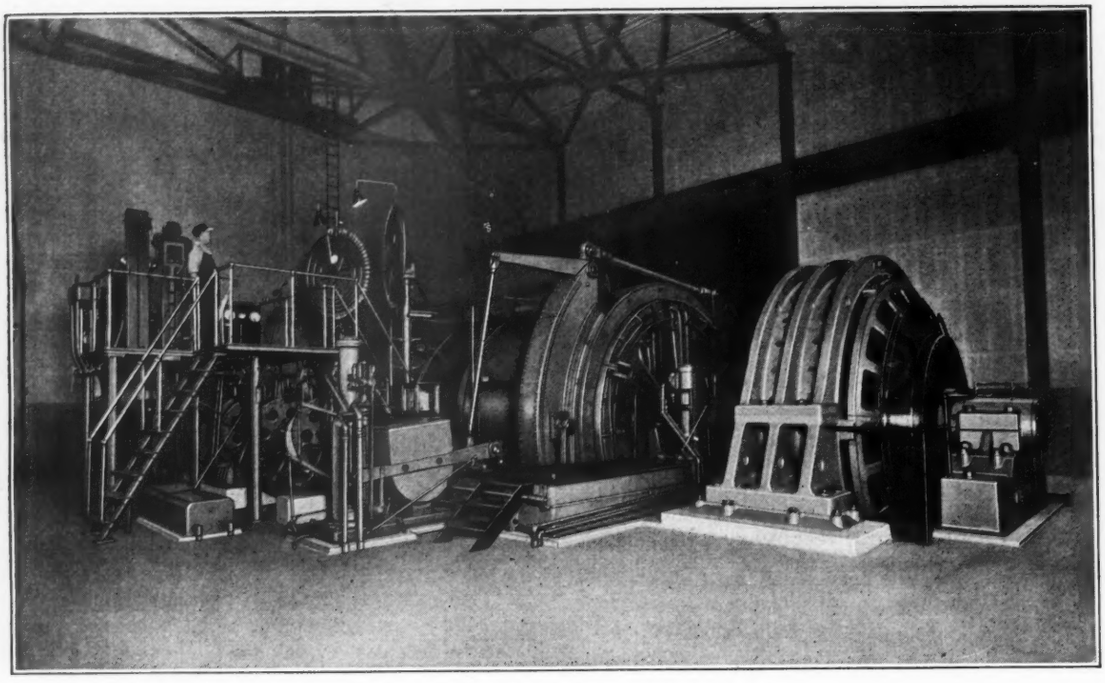

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Editor

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Mr. Hoover Points With Pride and Views With Confidence

MR. HOOVER'S speech of acceptance of the Republican nomination, on Aug. 11, was an able summing up of the creditable accomplishments in the United States in the last few years and of what we should look forward to in the future. In private life Mr. Hoover is a mining engineer, but there was nothing in his address about the mining industries—petroleum, coal or metal—though much attention was devoted to a well-considered discussion of aid for agriculture. He did, however, speak favorably of the increasing organization of trade associations and the broader dissemination of information thereby secured. He emphasized the fact that various industries could do much, by initiative, to promote their own good; but the function of trade associations is not alone "to cure their own abuses" but also "to serve public interests." In view of the recent comparative stabilization of copper, zinc, and lead prices, it is reassuring to have Mr. Hoover state that "The ideal state of business is freedom from these fluctuations from boom to slump which bring on the one hand periods of unemployment and bankruptcy and, on the other, speculation and waste."

It is not Mr. Hoover's idea that large corporations should obtain a control over industry and that competition should be stifled. "Both small and big business have their full place," he says. "The test of business is not its size. The test is whether there is honest competition, whether there is freedom from domination, whether there is integrity and usefulness of purpose." Referring to the independent business man, Mr. Hoover states that "we must maintain his opportunity and his individual service," to which sentiment there will be general approval.

How *Not* to Help the Weak Position of Tin

SPECULATIVE INTERESTS in London recently rushed—rather hysterically, some market observers in London declare—to the support of tin. As a consequence, after dipping to the lowest point reached since 1924, prices recovered somewhat, though they are still 50 per cent below the peak reached in 1926. In view of the fact, however, that there is known to be plenty of actual metal both in Europe and the United States to meet current requirements, the existence of a backwardation of about £2 shows clearly that the strength of spot metal is purely artificial.

This situation may be profitable from the standpoint of the London trader and speculator in metals; but it is bad medicine for an ailing tin-mining industry—or an industry that is threatened with illness. And it will do no good for the owners of shares in tin-mining companies. Producers that had considered the advisability of curtailing mine output will be encouraged by the upturn of the market to continue; smelters will be inclined to speed up production of refined metal to take advantage of the relatively high price for near-by delivery. Coincidentally, many consumers who have been led to think that lower prices are to be expected will begin to wonder whether the belief is warranted, and the tendency will be to hold up plans that might have involved the increased use of tin. Artificial boosting of the price at this juncture, if persisted in, is likely to prove a boomerang, and result in a decline even more marked than the "pessimists" have foreseen.

Arizona Copper Merger Doubtful, Despite Reports

AMONG the favorite sports of financial writers is to merge copper companies with each other—on paper. The latest report that has gone the rounds names five Arizona companies, Phelps Dodge, Calumet & Arizona, New Cornelia, Magma, and United Verde Extension, as the constituent units of a prospective "giant" consolidation. Possibly there were one or two others; if so, it makes little difference except that the difficulties of effecting a merger would be complicated further.

The trouble arises in reaching an agreement in the appraisal of the value of the various properties on which to base an exchange of stock. Not only must the directors of each company be satisfied, but the shareholders themselves can upset the plans of the directors if they feel that their particular company is getting the worst of the trade, and shareholders have a habit of thinking that their own mine is a pretty good one.

A few years ago when plans were being carried out for the union of the present Nevada Consolidated trio—Nevada itself, Ray, and Chino—many obstacles arose, and time, patience, and tact were required for successful accomplishment. In this instance not only were the officials who dominated the policies of the companies largely the same individuals, but the orebodies were susceptible to accurate measurement and sampling, so that engineers were able with confidence to reach an estimate of the relative value of the properties.

In the present instance neither of the foregoing favorable conditions exists. Ownership and administration are distinct. Some of the deposits are "disseminated" like those of the Nevada Consolidated group, but others

are of the vein type, and much guesswork would be involved in arriving at an estimate of the fair value of the property. The honest appraisal of two qualified engineers could vary by millions of dollars.

That some advantages would arise from a merger of this kind is obvious: control of production would be centralized, administrative and overhead costs would be reduced, and operating economies, particularly at Bisbee, would be effected; but these facts do not remove the inherent difficulties. Another factor is that the copper-mining industry is in a better position economically than it has been for some years and the outlook is good. Consequently, the incentive of financial necessity is lacking at this particular time.

An official of one of the companies involved has said that he knows nothing of negotiations looking to a merger of this character; but it may be assumed that he would be extremely reticent about verifying a report even if it were authentic. Denials in matters of this kind are the prerogative of officials, whether the rumors are true or not. Possibly an agreement will be reached whereby two of the companies mentioned will get together; but it would be surprising if a wholesale merger of the kind suggested were to be effected within the next year or two.

The Shift Boss — Is He a College Graduate?

EASILY one of the most important links in the chain of administrative organization in any industrial enterprise is the shift boss—the individual who as foreman or sub-foreman is in immediate direction of the men who actually perform the manual operations. Particularly in underground mining is this true; the efficiency of the entire operation hinges in a large measure upon the caliber of the shift bosses. The peculiar characteristics inherent in underground work require that the shift foreman shall combine to an unusual degree good judgment, tact, leadership, and practical knowledge of and experience in mining.

Ten years ago the school of mines graduate, as a shifter, was taboo in many districts. He "knew too much" was the objection of many mine superintendents. He could survey, sample, measure contracts or "keep time"; but by and large he was not wanted as a shift boss. Some young collegians have the grit and determination to go through an apprenticeship of actual mining—mucking, running an air drill, helping a timberman. There is no question that college training gives the right sort of young man certain equipment that is useful to him as shift boss; but he must learn the ropes of the job as a practical miner. It is generally agreed that between two men who are equally successful as shift foremen, the one who has been through the school of mines has a distinctly better chance of becoming a superintendent than one who has not.

Probably the proportion of shift bosses that are graduates has increased in recent years. Several reasons for this trend may be mentioned—assuming that it exists. The tendency toward more elaborate organization of mine forces, by which the personal responsibility of the shift boss is lessened—and incidentally the increased amount of bookkeeping, as the "practical" shift boss is likely disparagingly to style the making of any kind of written report; the growth in the number of graduates and the consequent keener competition for jobs available around a mine; the tendency to improve the conditions of health and safety and the introduction of more machinery underground, which have removed or lessened some of the disagreeable conditions that used to prevent young men from selecting underground work—the foregoing are some of the factors.

We have in mind the making of an investigation to ascertain just what the trend has been in this direction. The attempt will be made to find out how the proportion of college-trained bosses compares with the proportion ten years ago; the reason for the change, if—as seems probable—there has been one; and the opinion of representative mine managers or superintendents as to what kind of men make the best shift foremen—and why.

The Fable of a Designing Engineer

ONCE there was a young engineer who had never learned to think. Save for this, he was as perfect an engineer as one could wish, with his high-top shoes, corduroys, Stetson hat, and slide rule. Standing one day at the threshold of his career he foresaw that some time, if fortune favored him, someone might call upon him to design and build a plant. Long he pondered on how he should best prepare for this. At length an idea struck him. He had learned by observation that blueprints, tracings, and the like figured importantly in all design work. So he resolved that he, of all men, would have the finest collection of blueprints that it was possible to get together, and thus be ready, when opportunity knocked, to build headframes, and to lay out mills and smelters; in fine, to do anything that called for putting three timbers or I-beams together or for hooking up a ball mill with an agitator, or a roaster with a furnace. Firmly he carried out his resolve. No housewife ever hoarded string and paper as carefully as he his precious drawings. No sketch was safe around him. His collection grew. Tracings, prints, and what not, rolled and flat, went into his offices, until his quarters looked like the library of Alexandria before the fire. Finally it came about that his collection was complete. No plant or structure stood on earth but what had duplicates of its plans nestling in his archives. His preparedness made that of Germany look like a total lack of foresight.

The great day dawned. Drawn by the engineering aspect of our hero's *tout ensemble,* a man with real cash to spend gave him a contract for a plant. Like a bolt to its nut, or vice versa, he applied himself to his task. Not for nothing had he brought together this huge collection. Donning roller skates, he dashed down the aisles between the rows of cabinets, bins and pigeon holes housing the precious prints and sketches, stopping here and there just long enough to extract some wanted drawing. His selection made, he returned, and, taking off his skates, sat him down in quiet to his problem. Skill with jigsaw puzzles, acquired as a child, here stood him in good stead. His drawings—a shafthouse from South Africa, a crushing plant from the iron country, a porphyry flotation plant, roasters from an ancient smelter, a cyanide plant from Cripple Creek—all these, combining the latest wrinkle with the most ancient tried devices, he neatly pieced together. To work out the flow sheet and draft the specifications took but an hour more. Thus he designed his *magnum opus.* On completion the plant worked perfectly (this being still a fable).

Differentiating Between an Investment and a Speculation

NO SHARP LINE of demarcation exists between an investment and a speculation, the difference being one of degree of risk and profit. The dictionary states that to invest is "to lay out money for profit," whereas speculation is defined as "engaging in business out of the ordinary, or by dealing with a view to making a profit from conjectural fluctuations in the price rather than from earnings or the ordinary profit of trade, or by entering into a business venture involving unusual risks for a chance of an unusually large gain or profit."

A publicist recently announced that fortunes in the United States are not gained by speculation; but nevertheless, the taking of some chance, technical or commercial, is an invariable accompaniment of the accumulation of great wealth and in the attainment of high and influential position.

The viewpoint of a nurtured conscience that objects so vehemently to sanctioning profit as a result of chance is doubtless clouded by a consideration of conditions that occasionally surround commercialized endeavor in this direction, which, as Gilbert would say, "have nothing to do with the case." Objectors to betting usually forget that they patronize the practice in respectable guise when an insurance policy is issued to them. The purchaser of a travelers' policy, to quote a common example, bets 25 cents to $5,000 that he will meet with an untimely end within the period of hazard. A feeling of security can usually be purchased, which is recognition of the fact that chance plays a large and important part in our daily life. It is not inherently immoral or unmoral to anticipate what chance may have in store for us by making provision for every emergency and insuring against loss or disaster.

Moreover, the element of chance introduces spice into daily life. In some countries a large proportion of the population lives in a condition of perpetual hope, in return for a modest expenditure per week for a lottery ticket. Some one must win and some one does win, and the thought or the happening brings temporary or permanent relief from what is usually a major worry of daily life. In some other countries, usually where gambling on a colossal scale, but in different form, brings no rebuke, the lottery principle is spoken of as an evil influence, although it has been used as a valuable source of revenue in national emergency, when a particular type of conscience undergoes temporary dislocation. Consistency is a jewel—and as rare.

The element of chance plays an important part in the initial discovery of a mine, in the ease or difficulty with which it may be developed, in the application of principles that may have been proved sound elsewhere, in the program of research and experimentation adopted to point a way to commercial success. Curiously enough, there is little of the gambling element in fake mining promotions unless the buyer of the stock expects to make a quick turnover. The promoter counts on a sure profit, and the one who buys and keeps the shares will almost certainly lose. In a legitimate mining enterprise, however, the lack of certainty as to discovery and profitable development, and the prospect of success out of all proportion to the investment made, provides the incentive to "take a chance." The rewards, if they materialize, are all the greater to those who do so.

To wait for the happening of the inevitable is to stagnate. Fortune and success come to those who can plan ahead to take advantage of possibilities beyond the viewpoint of the pessimist and the skeptic. But speculation, a sign of virility, must be tempered by experience and governed by a sound conservatism which insists that the size of the possible winning is in proportion to the degree of risk involved. And further, speculation should be indulged only to the extent that the particular individual can afford to take a chance.

Increasing Importance of Domestic Quicksilver Industry

QUICKSILVER attained the distinction in 1927 of being the only important nonferrous metal for which higher prices were secured than in 1926. The low average price of $45.46 per flask in 1921 has been followed by steady advances in price, culminating with an average price of $118.16 in 1927, and $122.81 for the first six months of 1928. Continued higher prices have served to draw attention to domestic resources, and in the last two years the industry has shown signs of assuming sizable proportions. Depending largely upon a continuation of current price levels, the situation has its weak points, particularly because of the proclivity for political juggling by the Spanish and Italian interests, which control at least 75 per cent of the world's production. However, if the domestic producers are able to continue operations under present market conditions, it appears that an important addition to the non-ferrous metal industry of the United States may result. The domestic market is extremely sensitive, and the increasing rate of domestic production is being reflected in sharp competition between the more important sales agencies in this country.

There is opportunity for new mining equipment in this field: air compressors, rock drills, hoists, mine cars, and small accessory tools. In metallurgical treatment of the ores: crushers, rotary furnaces, screens, picking belts, feeders, and condenser equipment are needed. A power plant, usually of the Diesel type, is necessary. Quicksilver properties frequently are situated in isolated localities where the services of power companies are not available, and they must therefore generate or otherwise supply their own power requirements. In a few instances where open-pit operations are practicable, small power shovels may be installed. These are usually operated by internal-combustion engines. One company in Lake County, Calif., is installing a screening, picking, and flotation plant, although quicksilver ores are not usually concentrated, because of the low cost of direct reduction. In the aggregate the equipment required in this revival of interest will be of considerable proportions, though the plants are of relatively small capacity, as the daily tonnages treated do not often exceed one hundred tons.

Most needed in the quicksilver-mining industry is systematic development of deposits, which is particularly difficult because of the extremely irregular and "spotty" nature of most of the ore occurrences; thoroughly good mechanical equipment for exploration and development, and, where ore tonnages have been developed, well-constructed reduction plants of sound design. With a program of this nature, and assuming a continuation of the present price level, the industry should reach greater stability than it has attained in the past.

C. B. Lakenan Favorably Impressed With African Copper Deposits

An Interview By A. B. Parsons

HAD CECIL RHODES, instead of promising a "second Rand" in Rhodesia, foreseen a second Arizona, he would not have been so far from the mark, according to C. B. Lakenan, who, in the absence of a more accurate and less trite term, may be described as an American copper "magnate." He has just returned to New York after an 18-month journey in which he visited, among other places, the copper mines and near-mines of Chile, the Belgian Congo, and Rhodesia. Arizona being the premier copper mining state, the reader may deduce that Mr. Lakenan thinks pretty well of the prospects of developing, in time and with ample capital, a huge copper-mining industry in Northern Rhodesia. Mr. Lakenan, who, after 20 years with the company, recently retired from the active management of Nevada Consolidated, has given considerable study to the consuming side of the copper industry. He has become convinced that the demand throughout the world will increase rapidly, and his prediction is that before a great many years a large proportion of the world's copper will come from ores assaying less than 1 per cent, with higher per-pound costs; and that the price will be in the general neighborhood of 20c. He prudently avoids a precise timing of this eventuality further than to say he expects to see the day; and he is now just approaching his sixtieth milestone. Perhaps for the sake of his reputation as a prophet it is just as well that he appears to be in vigorous health and has inherited a good constitution. His father, originally from Virginia, traveled from St. Louis to California by the ox-cart route in 1851, settling in Grass Valley in 1855. He owned a foundry and machine shop, but, like most residents of the "Gold Crowned Empress of the Sierras," he was always associated with mining; and his son became a miner by virtue of his environment.

MR. LAKENAN graduated at the University of California in 1890, his course being mining and mechanical engineering. Subsequently he was a draughtsman in San Francisco and Boston for a year before going to Berlin and Zurich, where he spent five years in study. Thereafter he was engaged in sundry professional activities in California, Arizona, and Nevada for several years, finally, in 1907, going to Ely, Nev., as engineer under John Hays Hammond and Pope Yeatman for the Nevada Consolidated Copper Company. The enterprise had just been financed and construction had just started. Mr. Lakenan directed the building of the smelter and concentrator, which, by the way, as general manager, he has seen remodeled and rebuilt several times—once from the ashes of a fire that was probably one of those catastrophes that are really blessings. Under his nursing, Nevada Consolidated grew from infancy to maturity; he saw it through the hectic production period of the war; he guided its rejuvenation following the post-war depression and made of it one of the most efficiently operated and effectively organized copper producing companies in the country.

HOWEVER, one surmises, the constant study of cost sheets, the continued striving for further economies, lacked the zest demanded by one of Mr. Lakenan's imaginative and adventurous temperament. So, with the consent of D. C. Jackling, president of the company, he turned over the operating work at Nevada to experienced younger men in the organization, and on Jan. 1, 1927, started out from San Francisco to see the world. Once a copper man, always a copper man; so he steered his course for the copper mines of South America. Asked for his impressions, he said: "I was sorry that I could not conveniently arrange to visit Cerro de Pasco, although the officials whom I saw at the company's headquarters in Lima cordially invited me. The first thing that struck me at Chuquicamata was the vast scale of Chile's operations: the open-cut mine and the extensive reduction plants, as well as the complementary units, are spread out in one large panorama. The electrification of the mine transportation system as well as the shovels has been completed; the enlargement of the crushing and leaching units is accomplished; and the whole operation appears to be running most efficiently. Anaconda's other South American enterprise, Andes, had been in operation only a short time when I was there. However, I was impressed with the smooth running of the plant in the tuning-up stage. It reflects excellent design and careful construction work, which doubtless are a source of satisfaction to the New York officials, as they were to the management in South America. Though less spectacular in some respects than those of Chile Copper, the operations of the Kennecott property at Braden are no less remarkable. Caving methods of underground mining have been so skillfully applied and so well organized that per-ton costs compare favorably with the best attained in the United States. Moreover, substantial improvements have been made in both the concentrator and smelter in recent years, with resultant economies. When it is remembered that Braden ore is relatively rich—concentrator heads averaged almost 2.5 per cent in 1927—it can easily be appreciated that the plant operating cost of producing copper on a per-pound basis is perhaps not equaled by any other company in the world.

C. B. LAKENAN

AFTER a visit to the nitrate fields, Mr. Lakenan crossed the continent via the trans-Andean railway to Buenos Aires. He visited Rio de Janeiro and then sailed to Portugal. The conclusion of a leisurely tour of Spain, Egypt, Palestine, Syria, and other Mediterranean countries found him back in Paris. Here he was joined by E. S. Berry, of New York, and George W. Starr, president of Empire Mines Company, of Grass Valley, Calif. Together they journeyed to Cairo and thence started the 7,000-mile trip to Cape Town. Traveling by boat, rail, and motor car at various stages, the journey can be made with comparative comfort by the average tourist, provided that precautions against tropical diseases and infections are observed. In this connection Mr. Lakenan relates the following story:

"We had as fellow travelers two estimable grandmothers from Boston, who were touring the world and had already been in India and other tropical countries. Devout disciples of Mary Baker Eddy, they were obsessed with the idea that they were immune from attack by malaria-carrying mosquitoes and the tsetse fly with its sleeping-sickness germs. And they had the courage of their convictions. The rest of us wore mosquito boots and veils and nets, till we looked like deep-sea divers; the ladies, to their great comfort, dressed as if for a hot day on Boston Common. When we got to the copper region we left them, but by correspondence I have learned since that they got safely back to Boston free from infection of any kind. Berry and I escaped, but Starr was so badly laid up with malaria that he spent ten days in a hospital at Dar es Salaam, joining us later at Johannesburg. I am too old or too hard boiled to become a Scientist at this late day, but I confess the temptation to embrace the faith was strong for a while."

RECENTLY, Mr. Lakenan says, good progress has been made toward minimizing the danger from infected tsetse flies and mosquitoes in the copper-mining regions, by pushing the wild game, from which the tsetse gets its infection, back into the interior; and, by "forest-fire" methods, enlarging cleared areas around settled communities. As a matter of fact the copper regions are at an average elevation of about 4,500 ft.; the climate is good; and the country is by no means uninviting for the European or American mining engineer.

Progress in expanding output by the Union Minière, in the Belgian Congo, is slow but steady. In Mr. Lakenan's opinion the new leaching plant, designed to produce 30,000 tons a year, will not be in full operation for two years. He visited the new high-grade Kipushi mine, on the southern portion of the U.M. concession. It is the only underground mine in the group now operated; and it is being equipped with a modern hoisting plant to produce direct smelting ore. "Lack of sulphide ore," says Mr. Lakenan, "to facilitate metallurgical operations—both leaching and smelting—is one of the problems faced by Union Minière. Although the ores are in the sedimentaries, there probably are underlying igneous intrusions; and it seems to me possible that deeper and more extensive drilling might disclose ample sulphide ores. At least it ought to be tried. Northern Rhodesia is better off in this respect, in part at least, because development has been continued to greater depth. Indications are that enough sulphides will be found frequently to meet metallurgical requirements."

THE first property to become an active producer will be Roan Antelope; next will come N'Kana, owned by Bwana M'Kubwa, and then will come N'Changa. In one breath Mr. Lakenan emphasizes the splendid prospects for developing immense tonnages of 3 per cent ore, and for finding substantial additions to the productive areas; and in the next he emphasizes the long period of time that will be required to bring a newly drilled property into production, the large capital outlay

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Stope Control, Dilution, and Recovery With the Caving Methods

By CHARLES A. MITKE
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PRODUCTION of large tonnages of rock at a low cost is an accomplishment in itself, but low-cost tonnage alone is not sufficient in the metal industry. Every ton of ore in place has a definite metal content, and, that the greatest success be obtained, clean mining must be practiced. By clean mining is meant the greatest possible extraction of metal in the form of ore, at a low cost, with a minimum admixture of waste. This is the real problem of all caving systems, with particular reference to the branch raise, combined shrinkage and caving, and sublevel caving methods. In the last-named method, dilution is avoided to a large extent by carrying a timbered mat over the working stopes; in the two former methods, dilution has been largely overcome by practicing "stope control" or "controlled drawing." This requires constant vigilance on the part of the mine organization. The inquiry, "How many tons per man today, and of what grade?" is a common one at every caving camp.

In the branch raise and combined shrinkage and caving methods, the highest extraction is obtained by—

1. Thoroughly undercutting the block to be caved.

2. Isolating the block from the main orebody by carrying up narrow boundary shrinkage stopes on three, and occasionally on four, sides.

3. Close spacing of finger raises, and consequent closer spacing of parallel grizzly drifts, with greater height between grizzly and main-haulage levels.

4. Control of ore drawn through each finger, or drawing-off, raise daily.

The four operations mentioned above are not carried on separately, but are more or less simultaneous, and are interdependent. For example, if the plan is to force cave a block 150x150 ft. (after the development beneath has been completed), the block is only partly undercut; then the boundary shrinkage stopes are started, in both directions, from one corner. After these shrinkage stopes have been carried up to the top of the ore, drawing begins. The line of retreat is away from the corner, toward the solid. The moment drawing starts, undercutting is in process, preparing a second block; shrinkage stopes are being carried up, receding from the corner; further development work in preparing grizzly levels and putting up additional finger raises is going on, and controlled drawing is being practiced immediately under that part of the ore which is being mined. All operations are kept in step with one another.

The rapidity with which a block will settle, as a result of forced caving, is controlled by the rate at which the undercutting progresses and the rate at which the shrinkage stopes are carried ahead of the drawing. Seldom is it necessary to put up a boundary shrink on the fourth side, although this is occasionally done.

When a block is merely undercut and drawing started, though a fair extraction may be obtained, it is found that waste is more difficult to control, and will make its appearance in the chutes sooner than when the block is isolated with boundary shrinkage stopes.

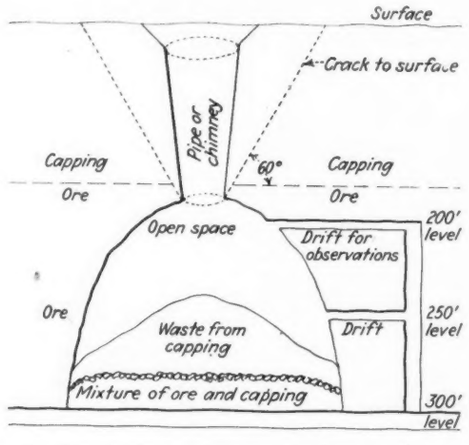


Fig. 1—Mechanics of ground when caving occurs (arching effect)

ORIGIN OF BOUNDARY SHRINKAGE STOPES

The purpose of boundary shrinkage stopes is to isolate completely from the main mass the block of ore which is being undercut and drawn. Boundary shrinks formed a part of the block-caving system used at the Pewabic mine, on the lower Menominee Range, in Michigan. Development at this property consisted of blocking out a section of the orebody, approximately 250 ft. square and 100 to 125 ft. high, by means of drifts and crosscuts, which divided the main block into smaller blocks or pillars. Stopes were then started above the footwall drift and across one end and carried up to within 20 ft. of the level above, leaving a back pillar above the drifts and crosscuts below to hold the broken ore on which the men worked while carrying up the stopes. When the stopes reached the required height, these pillars were drilled and blasted—the north and east corner of the block being blasted first. The stopes were then cleaned out from footwall to hanging wall and from end to end.

At the close of the development stage, the block, approximately 250 ft. square and 100 to 125 ft. high, had been

This is the twelfth and final article of the series by Mr. Mitke, in which he has outlined modern stoping methods.

cut off on all but the hanging-wall side, and rested on pillars about 22 ft. square. The pillars were then weakened by drilling and blasting, and caving followed, resulting in the entire block breaking down and dropping approximately 8 ft., when drawing was started. In this method, however, drifts were driven through the caved mass and considerable hand shoveling of ore into cars was necessary.[1]

Mechanics of Ground Movement

At nearly all of the porphyry-copper companies the doming effect usually takes place, and in all instances a block of ground to be mined must be cut off from the adjacent ore on at least three sides, in order to get the highest recovery. The mechanics of the ground movements and what actually takes place are illustrated in Fig. 1. Some time ago, at one of the large porphyry coppers, it was found that where an area 200x200 ft. square of fairly good caving ground had been undercut and drawn, only about 60 per cent of the estimated ore had been recovered before all the chutes began to run waste. A raise was put up from the undercutting level, approximately 100 ft. high, and about 20 ft. outside the stoping area. About 50 ft. above the undercutting level a crosscut was driven from this raise, toward the caved ore. After going approximately 50 ft., the crosscut broke through a shell of ore 30 ft. thick, and pierced red caved waste, which constituted the overburden. A second crosscut was driven, parallel to the first, but from the top of the 100-ft. raise, and after going about 75 ft. in the direction of the caving mass, it entered a cavity, having an arched back, with a small funnel-like hole in the center, open to surface. From this, it was clearly evident that the arch was supporting both the remaining unmined ore and the overburden, except that portion which, entering through the funnel at the top, was finding its way into the chutes beneath.

The hole, which had funneled through to surface, soon became a large glory hole, and the surface break assumed an angle of about 60 deg. As the hole at the top of the dome became larger and larger, as the result of drawing operations beneath, the angle remained approximately the same, but the subsidence area on surface became greater until the plane of the break had its origin down at the stoping level. To avoid a repetition of this condition, boundary shrinkage stopes were adopted at the large porphyry-copper companies.

Piping Caused by Uneven Drawing

Piping or, in other words, the forming of chimneys in the ore through which waste passes into the chutes is largely caused by uneven drawing. The tendency of the men is always to overdraw a chute which runs freely, and to slight those chutes which require frequent blasting. So much of the drawing, particularly from the square sets, is done in places where close supervision is out of the question, that minimum dilution depends largely on the integrity of the chute tapper.

There are instances where soft, moist ore shows a tendency to pipe, especially if it is sticky. In some places, the very soft ore, after it stands a certain length of time, becomes firm enough for small drifts to be driven through it without the use of timber, and when this type of ore is being drawn, small cylindrical pipes form through the ore to the capping, leaving the ore standing between chutes. In handling such a problem, a number of extra finger raises are driven from the grizzly level in the finishing-up process of a stope, thus greatly increasing the number of draw points, which really amounts to a closer spacing of chutes. In the Inspiration-Miami district there are just such instances of sections containing wet, sticky ore of a clayey consistency, which runs with great difficulty on angles of 55 to 60 deg. Such ore has a tendency to "hang up" in chutes, and in extreme instances motor cars must be put beneath the main transfer chutes, so that once drawing is begun in the finger raises, the ore may be kept moving until it reaches the motor cars. If it is once allowed to stop in the chute, and ten or fifteen feet of ore accumulates, it hangs up and gives considerable trouble in drawing.

In general, in the harder ores, the chutes run freely, especially when the ore breaks up and disintegrates rapidly, and drawing is accomplished with greater ease than in the softer material mentioned above. In blocky ores, an excessive amount of blasting must be done at the square-set and grizzly level. The finer material which often forms the capping has a tendency to run through cracks and find its way into the chutes. Even though such chutes are closed temporarily when capping makes its appearance, when they are reopened later, and drawing is resumed, it is often difficult to obtain as clean ore as formerly.

Experiments Prove Existence of Cross Currents

When capping makes its premature appearance in a chute, it is frequently the custom to seal the chute and continue drawing from other raises, returning to the first chute later, when it is believed that movement in the broken ore above has displaced and broken up the pipes, or chimneys, which were allowing waste to be drawn. Though of course it is impossible to see what is actually taking place in a caving mass when the ore is being drawn, as a result of interesting experiments, nevertheless, we know that, in addition to a general downward flowage of ore toward the chutes, there are a number of cross currents in various directions. Experiments in several orebodies, made by placing 10-in. to 12-in. cubes of wood at regular intervals in old prospect drifts, in a block about to be caved, indicate that each chute does not always draw the ore lying directly above it in a vertical column. These cubes (which bore inscriptions giving their original location in the block and the date they were placed there) often made their appearance in unexpected places. Frequently, a cube originally placed in a lower drift showed up in the chute much later than cubes placed in drifts higher up. Likewise, cubes that were in drifts at one end of the caving block were drawn out of chutes at the opposite end, while cubes placed near the center of the block might appear in central chutes or toward either end. These experiments were conducted in blocks where great care was given to stope control, or controlled drawing.[2]

This unusual migration of the wooden cubes was probably attributable to a difference in consistency of the ore itself and in its breaking qualities, as some rock breaks up fine and the rest coarse. Fault planes, water courses, difference in hardness, and other related factors also account for irregular movements in the ore mass. Laboratory experiments with boxes of sand, though giving interesting results, cannot, of course, give a clear picture of the internal rock flowage in a caving block, as

[1] "Block-caving System at Pewabic Mine." A. J. Myers, Vol. 21, Lake Superior Mining Institute Proceedings, 1916-17.

[2] Discussion of paper entitled "Cost and Extraction in the Selection of a Mining Method," page 207, *Trans.*, A.I.M.E., Vol. 55, 1917.

it is impossible to reproduce exactly such natural conditions as those described in the foregoing.

The question as to the angle which should be maintained between the broken ore and waste, during the process of drawing, is one that is still receiving considerable attention.

If too few chutes are drawn, so that the drawing angle approximates the vertical, the mass takes on weight and an excessive dilution is likely to result. On the other hand, pulling a large number of chutes beneath an extensive area, drawing the same tonnage from each, thus maintaining a horizontal subsidence, and repeating the operation until all the ore has been extracted, should give the best results, theoretically. However, it must be realized that, in practice, only a limited area can be opened up for drawing operations at any one time, and this scheme would require the undercutting of a block of prohibitive size, and the maintenance of a large number of chutes, which eventually would necessitate excessive expenditures for repairs and upkeep.

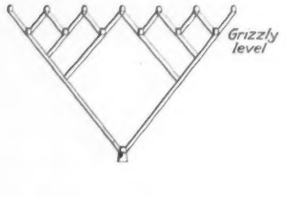


Fig. 2—Branch raise system in general

Efficiency, upon which depends a low mining cost, demands that as large a tonnage as possible be drawn from a minimum-sized area open at any one time. This implies very rapid drawing, and the maintaining, as nearly as possible, of continuous motion in the descending rock. Even though it were possible to maintain a horizontal position for the caving ore, some ground, as previously mentioned, has a natural tendency to "pipe," and the ore above chutes would soon form circular channels extending up through the block until they finally tapped the overburden, at which point they would become carriers of waste.

The angle of caving is influenced by a number of factors, chief among which is the character of the ground being caved. The nearer the angle approaches the horizontal, the greater the tonnage that can be produced—this being, of course, regulated by the policy of the company. The practice, in general, is to maintain an angle of approximately 60 deg., which usually allows the drawing of the required tonnage from a comparatively limited area, without an excessive dilution. If, however, stopes get heavy where this angle is maintained, the weight is removed by carrying up additional boundary shrinkage stopes at different places throughout the block, which has the effect of subdividing the original block.

The usual procedure in drawing a porphyry orebody is to start operations at the extreme end of the block, and retreat toward the solid, drawing the chutes in such a manner that the top of the ore block gradually assumes an angle of about 60 deg. away from the direction of retreat. It is believed that by maintaining a definite angle between the ore and waste, movements are created in the broken mass which tend to break up vertical pipes to the capping, and thin pillars between chutes, and that this has consequently resulted in better extraction.

Stope control is maintained by measuring, or gaging, the volume of ore drawn through each finger raise. In the branch-raise system, each finger raise generally serves a horizontal square, approximately 12½ ft. on a side, or an area of 156¼ sq.ft. The height may be anywhere from 75 to several hundred feet. As 12½ cu.ft. of the average caving ore weigh one ton, each square 1 ft. high would yield 12½ tons. Therefore, if the height of the block to be caved is known, the tonnage each finger raise should produce can be readily calculated.

It is important to have a record of the tonnage drawn from each individual chute, as well as the early estimate of the tonnage served by each individual finger raise. This latter is generally known as "the expectancy," and the former is the actual pro-rata tonnage produced. By referring to these records and comparing them, it should be possible to tell at once, when capping makes its appearance, whether the larger percentage of the ore has been extracted and excessive dilution may be expected from then on, or whether the capping is the result of piping.

Various methods of measuring the ore drawn from the small, or finger, raises have been tried out. In the early combined shrinkage and caving methods, the ore was drawn from short chutes, resembling individual finger raises, spaced at equal distances along the sides of drifts. The hand trams or motor cars were placed immediately underneath the chute or raise to be drawn, and an accurate measure of the number of tons taken from each chute was readily obtained. This is still used in occasional places at the Ray mines.

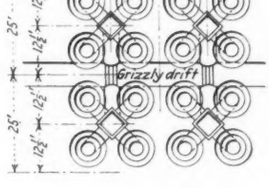


Fig. 3—Plan view of same. Each raise serves 156¼ sq.ft.

With the method employed by the Miami Copper Company up to and including 1925, "the chutes were originally installed on alternate sides of the tramming drifts, at 8½-ft. centers, and were maintained in this position until the chute was finally sealed. They were then moved across the drift and the small pillar of ore remaining between the original chutes on that side of the drift was drawn. The chutes in the changed position yielded from 15 to 20 per cent of the total ore expected from the chute. Records obtained from daily inspection from the completed drawing of 221,800 tons of ore through 271 chutes showed that 83 per cent of the original tonnage was drawn clean—that is, without admixture of capping; 14 per cent additional was drawn with less than 10 per cent dilution, and the balance drawn varied from 10 to 50 per cent waste."[3] This was an undercut caving system, by which all ore was measured into hand tram cars as it was being drawn, and then dumped into the transfer chutes, whence it ran into motor cars on the level below. Though furnishing very accurate results, it was what might be termed a high-cost caving method.

With the incline-raise system, no such measurement is possible. The ore is drawn through a square set from

[3]J. H. Hensley, Jr., *Trans.* A.I.M.E. Vol. 72, 1925, page 92.

a group of four finger raises, passes down to the grizzly level and into the main transfer chutes, and is finally drawn out into motor cars. The man in the square set cannot measure the ore by cars, as he is too far above the haulage level; likewise, the man at the car is too far beneath the finger raises to see what is going on there. Attempts have been made to put doors in the main ore chute beneath the grizzly, so as to measure a certain number of tons from each finger raise, but this was not found to be practicable, as the door was always getting out of repair, which delayed drawing operations.

In one camp, where, as a result of former exploration work, drifts happened to be at convenient short distances below the grizzly level, small haulage chutes, capable of holding from ten to thirty tons, were put up. The ore from each finger raise was run into the chute, or pocket, separately, and then drawn out into cars. By this expedient, the same amount of ore was taken from each finger, and a very even draw was obtained. However, the plan necessitated tramming the ore to a main haulage pocket, which increased the cost.

In the majority of operations, the haulage level is anywhere from 50 to 100 ft. beneath the grizzly level, so that it is impossible for the man in the square set (either on the grizzly level or in the raise above it) to know how many cars are being filled below, as the ore from two square sets and a total of eight finger raises passes into the main transfer chute (see Fig. 3). So far, no

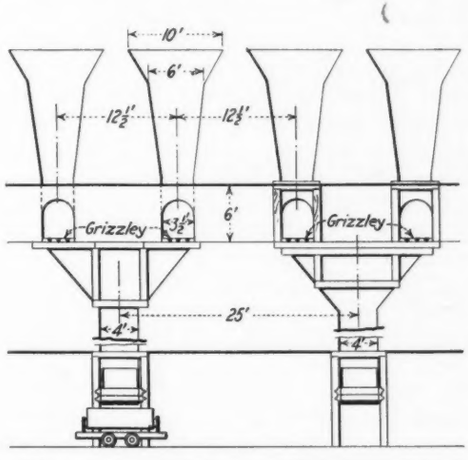


Fig. 4—Funneling out of Finger Raises

economical method of accurate measurement has been devised, and the chute tappers, when drawing, must trust largely to their individual judgment.

At some camps, chute tappers are given preliminary training, so that they may learn to gage the tonnage drawn from each finger raise more accurately. An engineer, whose duty it is to keep track of the tonnage drawn, instructs the tapper, during the training period, to draw from each finger raise in turn for the same length of time, approximately half an hour. After each individual raise has been drawn for half an hour, the engineer, using the telephone located on the grizzly level, calls the car checker below, to learn how many tons have been run, as measured by cars. This is only done, however, until the tapper learns approximately how many tons he draws in a given period of time. The average man can make a fair estimate within a couple of days, and then efficiency demands that telephoning be discontinued.

Rapid drawing is a necessity, and the chute tapper and car checker's reports are compared only by the engineer at the end of each shift, and the estimated tonnage from each finger raise is corrected by the actual tonnage drawn through the haulage raises into motor cars. In the course of daily drawing operations, the engineer walks back and forth along the grizzly drift, constantly making observations and noting the number of minutes the various chutes are being "pulled" or drawn, the character of material passing through the grizzlies, and the rate of flowage. Similarly, the shift bosses can also give the drawing-off operations closer supervision than where no grizzlies are used and they must climb a raise to each drawing-off chute.

With this practice, where careful supervision is exercised, it has been found that almost the same accuracy can be obtained in drawing from finger raises in the branch raise, or combined shrinkage and caving methods, as when all ore is measured into tramming cars.

Dilution and Recovery Depend on the Spacing of Draw Holes

A high percentage of recovery, with a minimum dilution, is dependent not only on "stope control" but also on the close spacing of draw holes. Even though careful supervision is exercised over the volume of ore drawn through each finger raise and grizzly, if these are spaced too far apart peaks will form between the drawing points in the broken mass above, and a low recovery will eventually be obtained, and waste from the capping may find its way into the chutes more easily through these pipes. It is the general belief that all broken and caved masses of rock really pipe to a more or less extent. Therefore, the closer the spacing of draw holes, the more this objectionable feature is eliminated. In general, closer spacing of draw holes, and stope control, will result in a somewhat higher mining cost, but the higher per cent of recovery more than justifies the additional expense.

The drawings (Figs. 2 to 14 inclusive) illustrate the spacing of finger raises and grizzlies now employed at properties using branch-raise caving and combined shrinkage and caving methods. Figs. 2 and 3 illustrate the spacing of finger raises as practiced at Inspiration, Miami, Nevada Consolidated (Ruth Mine), and Andes Copper. As may be seen from the drawings, the grizzlies are 25 ft. apart, along the grizzly drifts, and 50 ft.

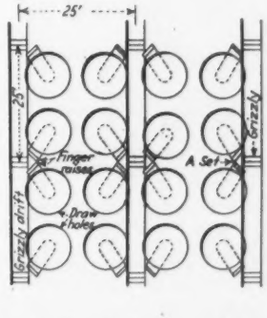


Fig. 5—"A" set form of timbering, and cribbing, used in Eastern iron mines. (Scale 1 in. in 10.) Each raise serves 156¼ sq.ft.

apart across the slope; and the inclined finger raises, where they reach the undercutting level, are 12½ ft. apart, center to center. These raises are only 3 ft. in diameter at the square set above the grizzly, but have been enlarged to 10 ft. in diameter immediately beneath the undercutting level, as shown in Fig. 4, thus presenting a funnel-like appearance. Each of these finger raises serves an area of 156¼ sq.ft., or approximately 12½ tons of ore for every 1 ft. in height. In average

porphyry caving ground, finger raises can hardly be spaced any closer than 12½ ft. As previously mentioned, the closer the finger raises are spaced, the more complete will be the extraction, but there is a limit to the nearness, in practical operations. Allowance must be made for the wear and tear on the sides of the raises, resulting from the constant passage of rock, which naturally increases their diameter, thus ultimately reducing the size of the pillars between them. In some operations, where

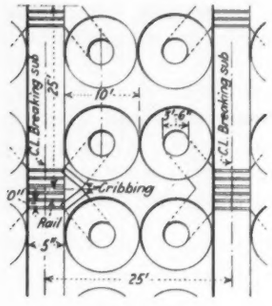
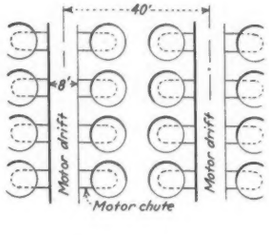


Fig. 6 — "A" set form of timbering on a larger scale. (Scale 1 in. in 5.)

the ground is very soft, the raises are belled out to a diameter of only 6 ft., instead of 10 ft., for, during the process of caving, the wear and tear will enlarge them ultimately to approximately 10 ft.

Figs. 5 and 6 are adaptation of the system described in the foregoing that are being used in some iron mines in Eastern states, where packy ground is encountered. They are also being used at some of the porphyry coppers. With this arrangement, all drawing is done from the grizzly level, rather than from the square set above. Two incline raises are put up from each side of the grizzly. These may be timbered in one of two ways. First, by building a regular square set over the grizzly and another set in the form of the letter "A" on each side of the grizzly; second, by building a regular set over the grizzly, but putting five sets of cribbing in each

Fig. 7 — Direct drawing from shrinkage stopes into motor cars at Ray. Each chute serves 250 sq.ft.



incline raise, so as to hold the ground during the process of drawing. In either event, the timbering must be made strong enough to prevent the ground above the grizzly from moving. Of the two methods of timbering, the second is usually preferable in very heavy ground, though the "A" set, which does not require so much timber, usually holds when the ground is a little firmer.

In the hand-tramming stopes at Ray, every raise also serves 156¼ sq.ft. This system has been used in places where the volume of ore did not justify a motor-haulage level. The ore was broken by means of shrinkage stopes, and drawn into cars, where the amount from every chute was measured and then trammed to the transfer raise.

In Fig. 7 the spacing of grizzlies and finger raises with the Ray motor haulage system is shown. These drifts are 8 ft. wide, and spaced 40 ft. apart. The chutes, which are really raises, are on 12½ ft. centers, and each raise serves 250 sq.ft. This arrangement of finger raises, without the use of a grizzly level, merely requires the expense of timbering the haulage levels with 12x12-in. timbers (regular tunnel sets) and then building pony sets above them (where the chute tapper draws the ore) and short inclines to the stopes and to the pillars. In the softer ores which lend themselves readily to caving, and which crush easily without leaving many boulders, this is a very cheap method, and it offers a rapid, efficient, and very economical way of drawing off ore. This, of course, would not apply where the weight on the haulage level becomes excessive, or where the ore breaks so coarse as to require a grizzly level. Even with the 250-ft. spacing, over a period of years, the system has been very successful in obtaining a good recovery, and as the ore was measured into motor cars, the capping was brought down very evenly without an excessive dilution.

Fig. 8 illustrates the spacing of finger raises and grizzlies employed at Morenci, in the combined shrinkage and caving. Here, the grizzlies are spaced 14 ft. one way and 28 ft. the other, and the incline raises at the undercutting level are also on 14-ft. centers. Each of these raises serves 196 sq.ft. The ground is firm at Morenci, so that even with incline raises at such frequent intervals, practically all the drifts stand without timber.

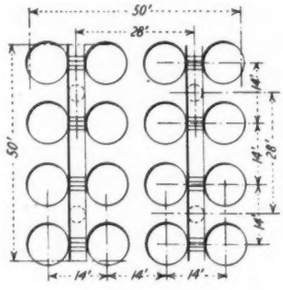
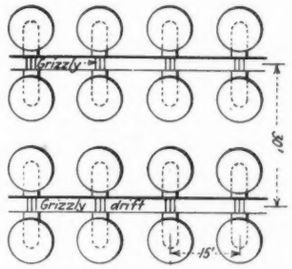


Fig. 8 — Spacing of finger raises—Morenci, 14-ft. centers. Each raise serves 196 sq.ft.

Fig. 9 illustrates the spacing of drawholes on 15-ft. centers, with grizzly drifts spaced 30 ft. apart. In this instance each finger raise serves an area of 225 sq.ft. Approximately 1,500 tons daily is being produced by this method in Arizona.

In Figs. 10 and 11 are shown arrangements used in conjunction with combined shrinkage and caving at some camps in Arizona. In Fig. 10 the grizzlies are staggered, and in Fig. 11 the same arrangement is given on a larger scale, but the grizzlies are opposite each other. When the grizzlies are staggered, the incline raises (which have an inclination of 45 deg. from the horizontal) are put up at right angles to the grizzly drifts; whereas in the other instance, the incline raises have the same inclination, but go up at an angle of about 30 deg. with the drift. Every finger raise serves an area of 312½ sq.ft. This is just twice the area served by the finger raises shown in Figs. 2 and 3. The method is, of

Fig. 9 — Spacing of finger raises for ore drawing in the Bisbee district. Each finger raise serves 225 sq.ft.



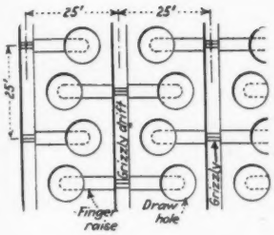


Fig. 10—Ore drawing system used with combined shrinkage and caving. Each raise serves 312 sq.ft.

course, very economical, as the drifts hold up better on account of having only half the number of incline raises. However, the estimated recovery is probably under that obtained with the closer spacing. About 3,000 tons per day is being produced by this method.

Another arrangement is that shown in Fig. 12. This is used in the hard ores at Creighton (International Nickel Company). The box holes, or large chutes, are 30 ft. apart along the side of the stope and 50 ft. apart across the stopes, but staggered at intervals of 15 ft. Each box hole serves an area of approximately 750 sq.ft.

Fig. 13 illustrates the spacing of grizzlies and raises at the Latouche mine (Kennecott, Alaska). Grizzlies

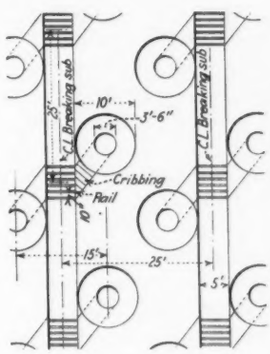


Fig. 11—Ore drawing system used with grizzlies staggered

are on 40-ft. centers one way, and 60-ft. centers the other, and two raises are put up from each grizzly. Each raise serves an area of approximately 1,050 sq.ft. After the stope is mined, a third raise (shown with dotted lines in the drawing) is put up from the back of the grizzly for the final clean-up.

In Fig. 14, the approximate spacing of raises and grizzlies at Alaska Juneau is given. The grizzlies are on 42-ft. centers one way and 80-ft. centers the other, each of two raises serving an area of approximately 1,680 sq.ft.

From the foregoing descriptions the reader may infer that the closer the spacing of raises the better the control may be practiced, and the higher the recovery, but the more costly the original development work. However, where there is great height above the undercutting

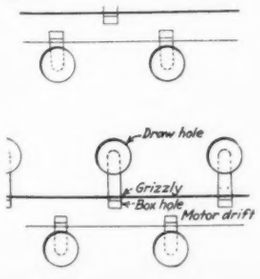


Fig. 12—Spacing of finger raises for ore drawing system at Creighton mine. Each raise serves 750 sq.ft.

level, the most expensive method may ultimately prove the most economical.

"Dilution" must not be confused with "recovery," as it is possible to obtain 100 per cent recovery and still have considerable dilution. The main object is, of course, to recover, as nearly as possible, the total metal content of the rock as given by the original estimates, with the addition of a minimum of waste. To recover this abso-

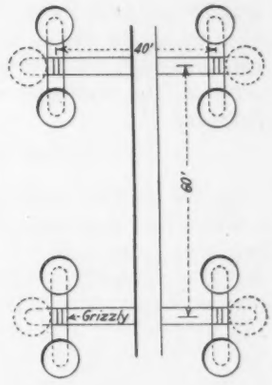


Fig. 13—Spacing of finger raises, or draw holes, and grizzlies at Beatson mine, Latouche Island (Kennecott). Each raise serves 1,050 sq.ft.

lutely clean would mean mining only the exact estimated tonnage, which would not permit of any dilution. For example, if the preliminary estimates indicate that a certain block of ground contains 1,000,000 tons, with an average metal content of 1.5 per cent copper, the purpose would be to recover this 30,000,000 lb. of copper, without mining any more than the original million tons of ore. However, such procedure might entail a prohibitive mining cost. If, in order to recover this copper, it is found necessary to mine two million tons of rock, the dilution is 100 per cent, even though complete recovery of the copper content is eventually obtained, and the recovery per ton of ore mined would average only 0.75 per cent copper, or 50 per cent of its original content. If, on the contrary, only 1,100,000 tons of rock is mined, and a complete recovery is again obtained, then the dilution is only 10 per cent, and the copper content of the ore mined would average 1.35 per cent copper. How-

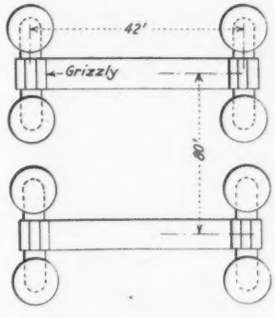


Fig. 14—Spacing of draw holes and grizzlies at Alaska Juneau. Each raise serves 1,680 sq.ft.

ever, in many instances there are obstacles to recovering the full 100 per cent of the metal content, as given by the original estimates, and it is generally considered better to sacrifice a small per cent of this—say anywhere from 3 to 10 per cent—than to mine and treat a large extra tonnage of waste in order to obtain 100 per cent recovery.

In general, dilution does not take place until a large per cent of the ore—say 60 or 70 per cent—has been drawn. From that point it gradually increases, until somewhere in the last 10 per cent the dilution eventually becomes

so great that the economic limit is reached when profitable mining operations cease.

At many of the low-grade properties, in the course of mining operations, additional ore is found and mined, other than that included in the original estimate of ore reserves, which somewhat complicates mathematical calculations as to recovery and dilution. Speaking of Inspiration, Mr. T. A. Rickard states "in one section of the stopes, 5 per cent more copper than was estimated, and 29 per cent more tonnage, were obtained, owing to dilution of the ore by admixture of the locally enriched cap, although 93 per cent of the copper, and 104 per cent of the tonnage, represents the current rate of recovery." [4]

Miami Stoping Records

In the former undercut caving stopes at Miami, at a time when approximately 2,577,734 tons, assaying 1.79 per cent copper, had been drawn from a section estimated to contain a total of 2,319,627 tons of ore assaying 1.986 per cent copper, the tonnage extraction was 111.13 per cent and the copper extraction 100.16 per cent. The extraction over 100 per cent of the copper was accounted for by the fact that the capping contained an appreciable amount of copper of which no account had been taken in the estimates. The "grade" extraction, or ratio of the grade of ore drawn to the grade of ore in place, was 90.1 per cent, and it was estimated that 80 per cent of the total tonnage was drawn clean, before any dilution appeared. Other stope records showed that 83 per cent of the original expected tonnage was drawn clean—that is, without admixture of capping; 14 per cent additional was drawn with less than 10 per cent dilution, and the balance drawn varied from 10 to 50 per cent waste.[5]

Since the branch raise method has been introduced at Miami, ten stopes, estimated to contain approximately 1,000,000 tons each, have been placed in production. "Stopes Nos. 1 and 2 were completely worked out in 1926, and produced 2,364,736 tons, assaying 0.9943 per cent copper, from an estimated tonnage in place of 1,951,252 tons, assaying 1.0654 per cent copper. This represented a tonnage extraction of 121.19 per cent and grade extraction of 93.33 per cent, resulting in a copper extraction of 113.11 per cent. The excess copper extracted came from overlying gob and capping not included in ore estimate."[6] Stopes Nos. 3 and 5 were mined out in 1927, with equally good results.

At Morenci, the dilution in all caving stopes in operation for eight months in 1925 amounted to 5 per cent. This was not the final figure for any given block, but was "an intermediate average between stopes just starting, where there is no dilution, and stopes in the later stages of production, where there is a maximum dilution."[7]

A block of ore 250x225 ft. at the Nevada Consolidated (Ruth Mine) was estimated to contain an expectant tonnage of 239,337 tons, with a copper content of 2.23 per cent. The actual extraction was 251,508 tons, with an average copper content of 2.07 per cent. It is calculated that 105 per cent of the tonnage and 97.8 per cent of the metal content were recovered.[8]

No figures are available as to dilution and recovery at Braden, the Andes Copper, Latouche, Creighton, or from the various mines using sublevel caving. At Alaska Juneau, "the assay value of all development and preparatory mining work samples taken between January, 1913, and December, 1920, averaged $1.09 per ton."[9] In 1925, the total tonnage milled is reported as 1,537,884 tons, and 1,943,896 tons were rejected as waste.[9] "The final mill feed had nearly twice the assay value of the ore trammed."[10] In 1927, a total of 4,267,810 tons was produced, averaging 77c. per ton; 56.89 per cent of the tonnage mined was sorted out as waste, before milling.[11] It should be stated that the ore is reported to occur in alternate bands of ore and waste, which are mined together, as, owing to the nature of the ore occurrence, the cost of separating them in the process of mining is believed to be prohibitive. Sorting at advantageous points in the mill is, therefore, practiced. A large percentage of the dilution consequently comes from the mining of these unavoidable bands of waste.

Feldspar Production Decreased 4 per Cent in 1927

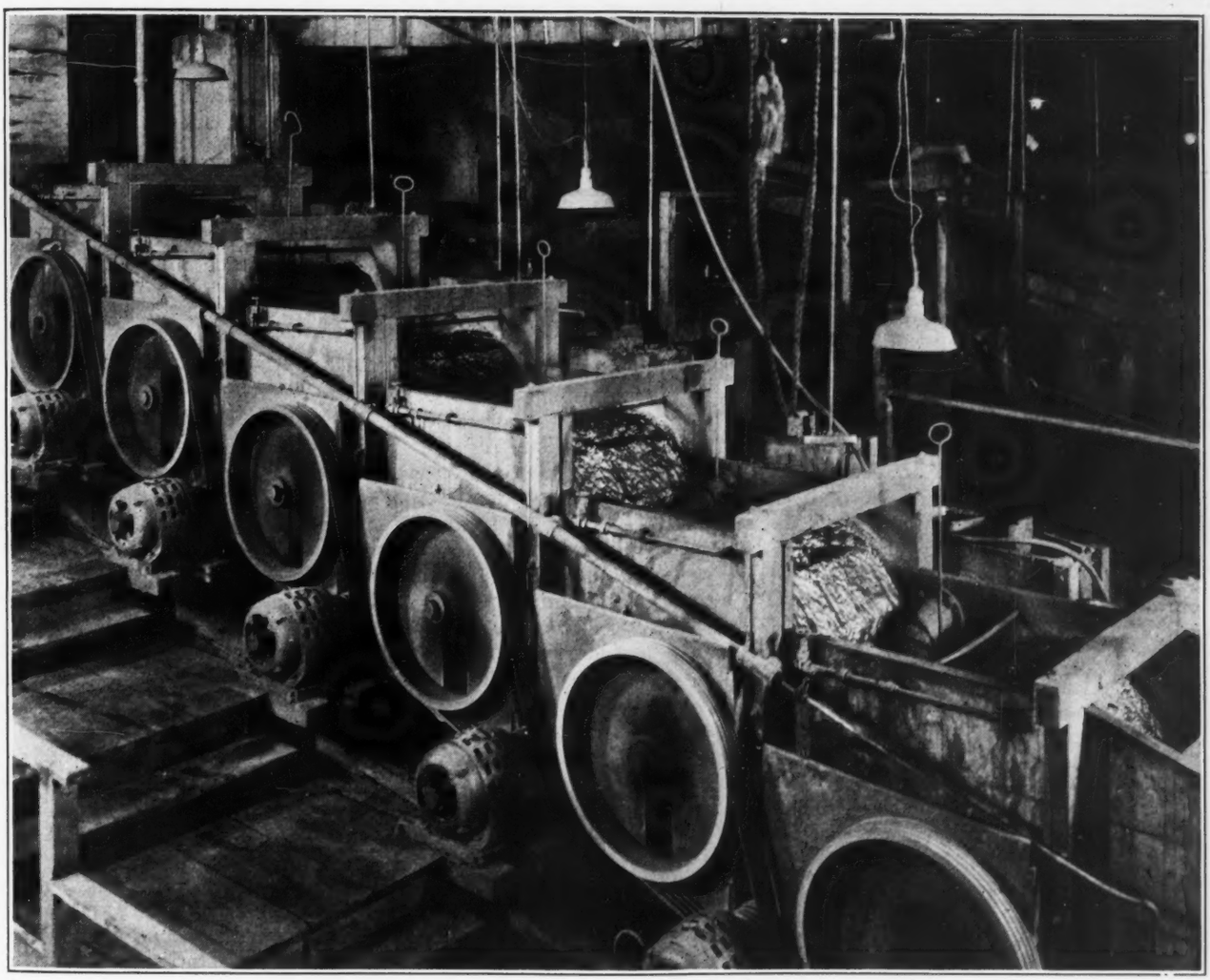
CRUDE feldspar sold or used by producers in the United States in 1927 amounted to about 202,497 long tons, valued at $1,424,755, or $7.04 a long ton, according to reports obtained directly from producers by the U. S. Bureau of Mines. These figures show a decrease of 4 per cent in quantity and 11 per cent in total value compared with the statistics for 1926. Feldspar was mined and sold in 1927 in twelve states—namely, Arizona, California, Colorado, Connecticut, Maine, Maryland, New Hampshire, New York, North Carolina, Pennsylvania, South Dakota, and Virginia. The greatest feldspar-producing region is that which includes the Atlantic seaboard states, from Maine to North Carolina. This region reported about 94 per cent of the total production and value in 1927. North Carolina, the leading state, reported about 50 per cent of the total output; Maine, the second state, reported nearly 17 per cent; and New Hampshire, the third state, nearly 14 per cent. The average value per long ton of crude feldspar in North Carolina was $6.08; in Maine, $8.72, and in New Hampshire $8.13.

Feldspar is prepared for use by grinding, largely at commercial or custom mills; only a very small portion is ground by users in their own mills. In 1927 there were 32 commercial mills operated in thirteen states—California, Colorado, Connecticut, Illinois, Maine, Maryland, New Hampshire, New Jersey, New York, North Carolina, Ohio, Pennsylvania, and Tennessee. These mills reported 223,915 tons of ground feldspar sold in 1927, valued at $3,564,141, or $15.92 a ton, compared with 225,362 tons, valued at $3,775,797, or $16.75 a ton, in 1926, a decrease of less than 1 per cent in quantity and 6 per cent in value. Of the quantity sold in 1927, 194,672 tons, valued at $2,946,154, or $15.13 a ton, was domestic feldspar, and 29,243 tons, valued at $617,987, or $21.13 a ton, was imported feldspar, including Cornwall stone. Imported feldspar was ground in two states in 1927—New York and Ohio. These figures represent an increase in imported feldspar compared with 1926.

[4] *Mining and Scientific Press*, Sept. 1917.
[5] "Mining Methods of the Miami Copper Co." J. H. Hensley, Jr. *Trans.* A.I.M.E. Vol. 72, 1925.
[6] Annual Report, 1927.
[7] "Mining Methods at Morenci," *Engineering and Mining Journal*, Dec. 26, 1925.
[8] "Branch Raise System, Ruth Mine," W. S. Larsh, *Trans.* A.I.M.E., Feb. 1918.
[9] Mines Handbook, 1926.
[10] "Mining Methods of Alaska Juneau." *Trans.* A.I.M.E. Feb., 1924.
[11] Annual Report, 1927, Alaska Juneau Gold Mining Company.

Flotation Equipment
OF THE
Combined Metals Reduction Company

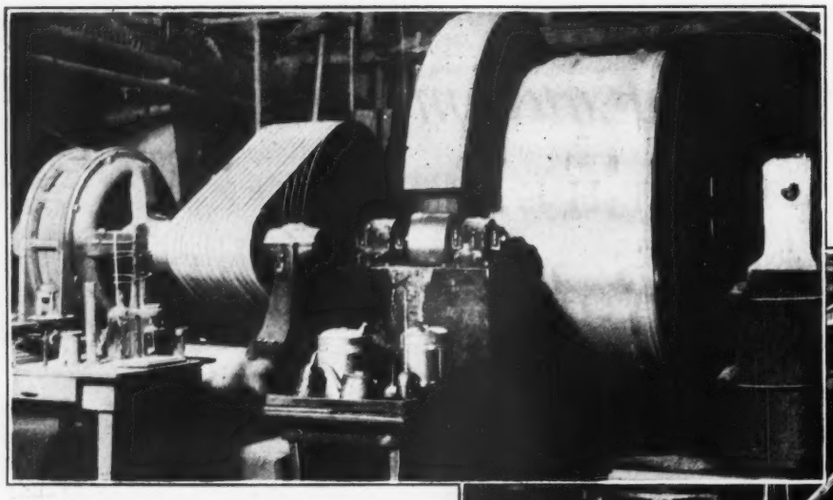
By H. D. KEISER
Assistant Editor



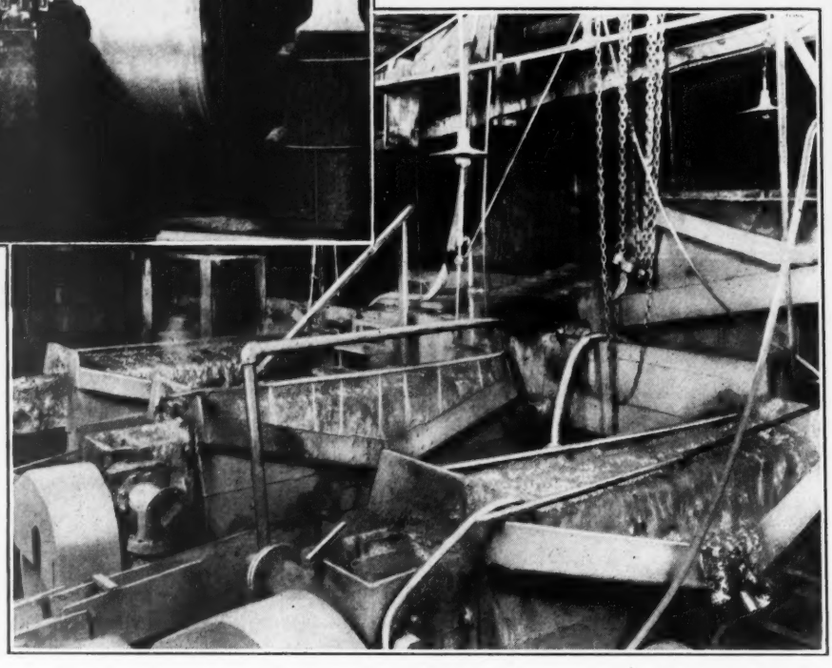
Six-cell flotation machine equipped with individual motor drives

APPROXIMATELY 200 tons of complex lead-zinc ore is being treated daily at the flotation mill of the Combined Metals Reduction Company, at Bauer, Utah. Fifty per cent of the ore is from the Pioche (Nev.) properties of the company, the remainder consisting of custom ores from widely scattered districts and that from the company's Honerine mine, at Bauer. Milling of these complex ores from such a number of sources has required considerable metallurgical study to obtain the degree of recovery desired. After much experimentation, an alkaline circuit and a grind of 75 to 80 per cent minus 200 mesh was adopted, with satisfactory results.

After dry crushing $\frac{3}{8}$ in., the ore is automatically sampled and delivered to fine-ore bins. It is then fed to a belt conveyor discharging to an 8-ft.x36-in. Hardinge ball mill that operates in closed circuit with a 54-in. Akins classifier of the submerged type. The ball mill

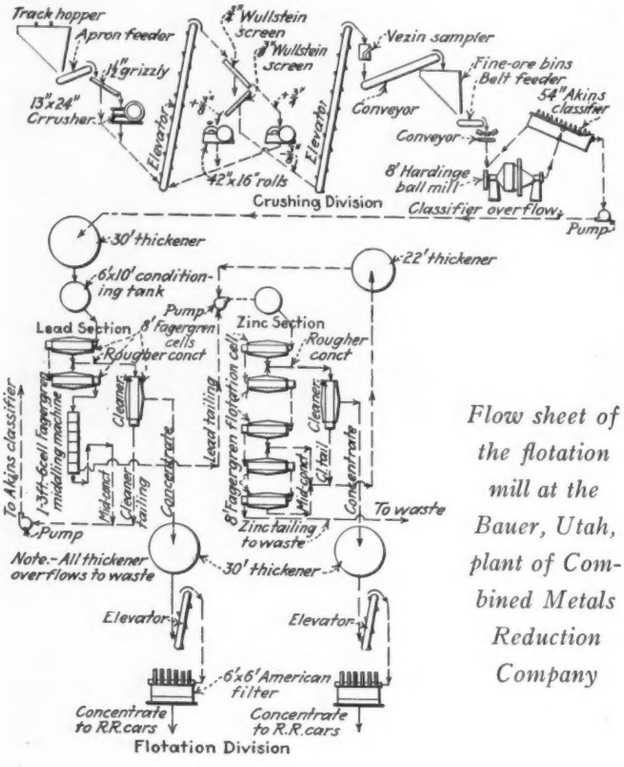


The ball mill and its motor drive. A section of the flotation department.



has a speed of 17 r.p.m., and is operated with a ball load of seventeen tons. Ball consumption averages 2 lb. a ton of ore ground; this is compensated for daily by the addition of 3-in. cast-iron balls weighing 4 lb. each. Discharge of the ball mill contains 85 per cent solids. Overflow of the classifier is 20 to 25 per cent solids, of which 80 per cent is minus 200 mesh and 95 per cent minus 100 mesh.

The flotation department comprises nine 8-ft. and one 3-ft. six-cell Fagergren flotation machines, with their attending pumps, thickeners, and filters. Overflow from the Akins classifier is pumped to a 30-ft. Dorr thickener, the overflow of which is sent to waste. The underflow, containing 38 per cent solids, passes to a conditioning tank, and thence to the lead flotation section, consisting of two rougher, one middling, and one cleaner machines. Concentrate from the middling machine and tailing from the cleaner are returned to the classifier. Concentrates from the roughers pass to the cleaner. Cleaner concentrate is thickened in a 30-ft. Dorr tank, and then dewatered on a six-leaf 6-ft. American filter. Tailing from the lead middling machine, after being thickened in a sludge tank, comprises the feed to the zinc section, consisting of two rougher, three middling, and one cleaner machines. Concentrates from the three middling machines and tailing from the cleaner pass to a 22-ft. Dorr thickener, where they are conditioned prior to being returned to the sludge feed tank. Rougher concentrates are cleaned and filtered in the same manner as in the lead section. Tailing from the zinc section is sent to waste.

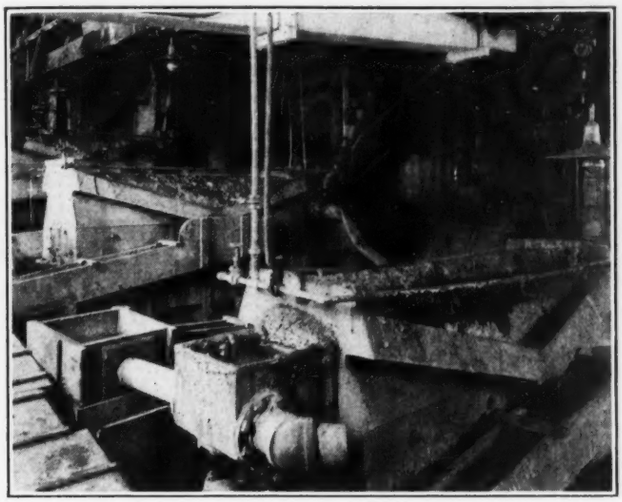


Flow sheet of the flotation mill at the Bauer, Utah, plant of Combined Metals Reduction Company

An unusual feature of the mill is the extensive use made of Texrope drives. All the flotation machines, Wilfley pumps, Akins classifier, elevators in the crushing department, and the line shaft of the vacuum pumps are equipped with these drives. The adaptation of this drive to the ball mill was the first application of this character in the United States, and has attracted considerable attention. In this installation, power is supplied by a 150-hp., 580-r.p.m., General Electric motor through twelve $1\frac{1}{2}$x1x240-in. Texropes, the driver and driven pulleys being 52 in. apart on centers. This drive has been in use sixteen months, and during this period has given very efficient service, not causing one minute's loss of operating time. It is noiseless, has not required any maintenance, and neither the ropes nor pulley grooves show any appreciable wear.

Each cell of the 3-ft. six-cell Fagergren flotation ma-

chine, shown in the accompanying illustration, is operated by a Texrope drive connected to a 10-hp. Fairbanks Morse motor, supplying the 6½ hp. required. Power for



Three of the 8-ft. flotation cells

the other flotation machines is furnished by Crocker-Wheeler motors of 15- to 25-hp. capacity.

Grateful acknowledgment is made to E. H. Snyder, general manager of the Combined Metals Reduction Company, for permission to publish this account, and to R. J. Evans, mill superintendent, who furnished the flow sheet and the data presented.

Sensitivity of High Explosives

AN ESSENTIAL characteristic of an explosive is that it shall be sufficiently sensitive always to detonate completely. An insensitive explosive constitutes a hazard because of the danger of drilling into charges of explosive which have partly misfired and the likelihood of a low order of detonation, and burning, in the borehole. The latter condition usually produces large volumes of poisonous gases and is particularly hazardous in gassy or dusty coal mines, where explosions may result.

An investigation of the sensitivity of various explosives under actual mining conditions is being made by the U. S. Bureau of Mines, with the objective of devising tests which will provide a measure of this property. Tests in boreholes in a coal mine (cartridges 1 in. in diameter, borehole 1¾ in.) have shown that for three typical permissible explosives detonation will propagate across air gaps of 8, 6, and 1 in. respectively. These distances are not much different from those obtained in paper tubes, but tests in steel tubing have indicated that the diameter of the borehole has a pronounced effect on the length of air space over which detonation will propagate. For example, in a steel tube 1⅜ in. inside diameter, gaps as high as 50 in. have been obtained with these same explosives.

Results so far obtained indicate that when cartridges of explosives are of much less diameter than that of the borehole, great care should be taken to insure that the ends of the cartridges are in contact. Otherwise there is danger of incomplete detonation of the charge. Further work is in progress, and the mechanism of the phenomenon is being studied photographically.

New Tin Dredges in Far East Number Sixty-nine

FREQUENTLY the question is raised as to the actual number of dredges at work, under construction, and under order on the Eastern tin fields. Such estimates as have appeared usually include only the Federated Malay States, but account should also be taken of the position in Siam and Burma. The *Daily Metal Reporter* gives data, to which it recently has had access, prepared by a leading tin firm in the Far East which indicate that the magnitude of the tin dredging industry is likely to be under-estimated. The figures are as follows:

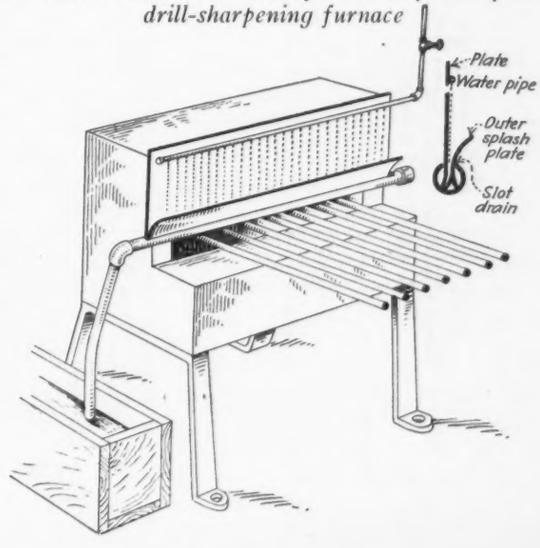
	At Work	Under Construction	On Order	Total
F. M. S.	72	21	23	116
Siam	17	13	8	38
Burma	6	3	1	10
Total	95	37	32	164

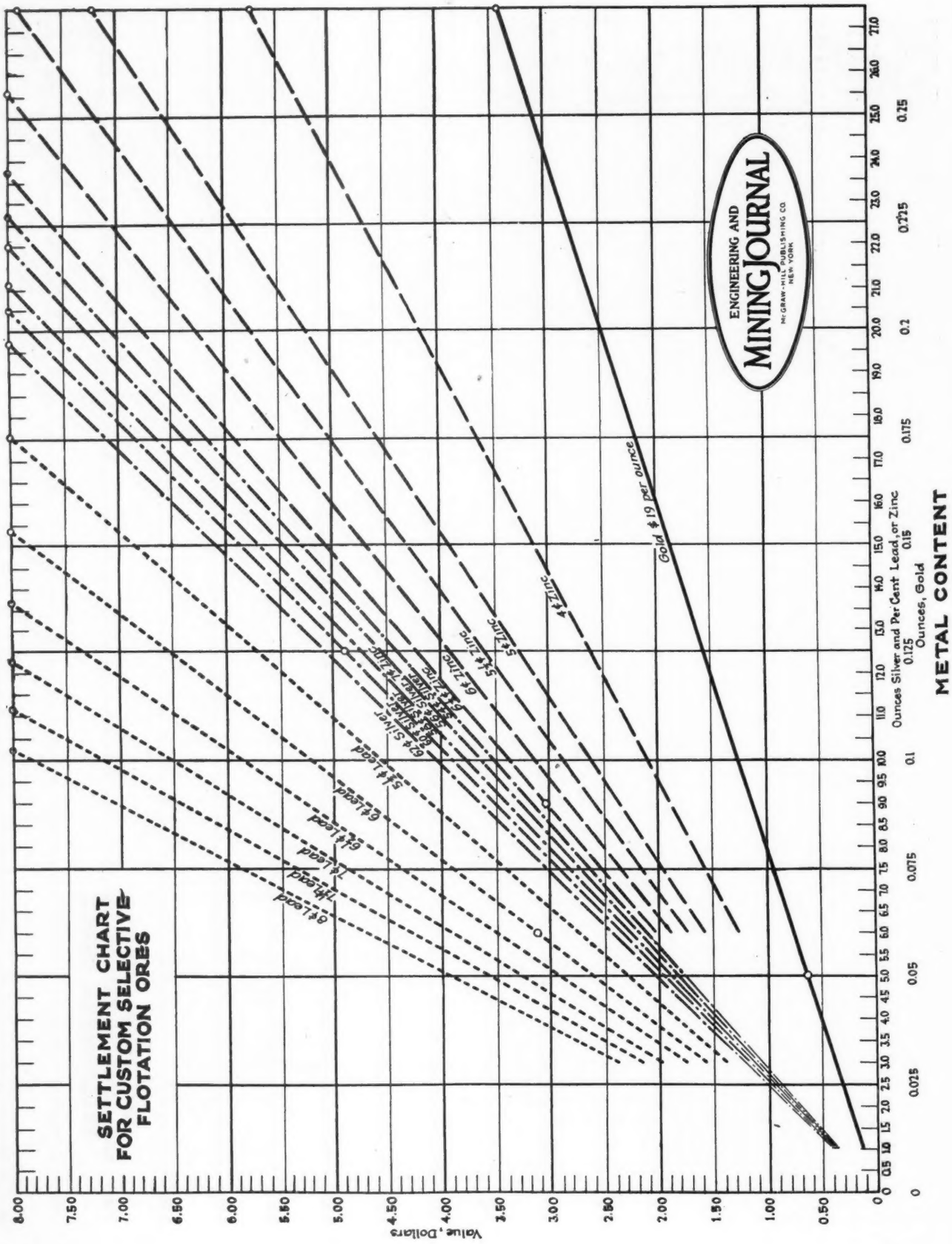
These figures, the writer comments, represent the position as closely as could be ascertained on Dec. 31, 1927, and take no account of additional undertakings announced since, such as the installation of a "fleet of dredges," the equipment of which was announced at the meeting of Anglo-Oriental on May 23, for the Lower Perak Tin Dredging, Ltd., nor does it include dredges which may be installed in the Dutch East Indies.

Making It Cooler for the Drill Sharpener

A DEVICE intended to reduce the heat radiating from the front of a drill-sharpening furnace is in use at a construction camp. It is shown in the accompanying sketch. A piece of sheet iron is suspended in front of the furnace. The lower edge is placed within a slot cut in a 1½-in. pipe. Near the upper edge a water pipe is attached. This is pierced with holes at intervals, and water is allowed to trickle down the plate, the surplus being carried off by the lower pipe. A piece of iron is placed in the slot in front of the vertical plate and serves to prevent splashing of the water. Both plate and pipe are so attached as to permit ready removal. The cooler is attached in such a way as to leave the slot of the furnace open for placing and withdrawing the drills.

A water-cooled shield is suspended in front of the drill-sharpening furnace




SETTLEMENT CHART
FOR CUSTOM SELECTIVE
FLOTATION ORES
ENGINEERING AND
MINING JOURNAL
McGRAW-HILL PUBLISHING CO.
NEW YORK
Value, Dollars
Ounces Silver and Per Cent Lead, or Zinc
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METAL CONTENT
Gold $19 per ounce
6% Zinc
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Analyzing Complex-Ore Settlements Graphically

By Homar L. Johnson
Assistant Editor

METALLURGICAL CALCULATIONS and the various methods of solving a metallurgical problem are always interesting, particularly to the metallurgical mathematician, or mathematical metallurgist, if you wish. Possibilities of reducing a complex calculation to a simple and foolproof form are always worth consideration. Large smelting plants make use of extensive charts and tabulated calculations in figuring furnace charges, but these are seldom justified for small operations, or in larger operations where only relative accuracy is desired.

Custom concentration plants which embody selective flotation of complex ores frequently require extensive facilities for metallurgical and plant control. Plant control in this connection is, by inference, economic control, as the operation depends for its ultimate success entirely upon the return in dollars and cents. The first essential in this type of plant control is to know the cost of the ore and probable value of the finished concentrates, assuming that operating costs are fairly well established.

Although these figures are precisely determined by the accounting department after the ore has been treated, they do the millman little good then, except to add to his experience. Assuming a selective flotation plant, operating on a custom basis and producing marketable concentrates of lead and zinc, the operating metallurgist has three primary economic calculations to consider: He must determine (1) the cost of the ore, (2) the value of the lead and zinc concentrates produced from the ore, and (3) consider each in correct relation to the others. These calculations may be made several times each day if the character of the ore is changing or if reagent variations are being experimented with. Consequently rapidity in calculation is essential, though the accuracy of the result need be relative, only. The slide rule provides the most rapid reasonably accurate method for calculations of this type in general use, but is by no means foolproof. Many competent metallurgists object to extensive reliance on slide-rule calculations, because of the influence of the personal equation on the results secured by the slide rule. However, for the complex metallurgical calculations concerned with many variables, such as smelter schedules or contracts under which the concentrates are marketed, it is the only practicable method of solution that combines reasonable accuracy with speed.

Where the number of variables is small, the problem is less difficult. The accompanying chart or graph illustrates a method that has found favor in arriving at settlement values for silver-lead-zinc flotation ores treated under a custom arrangement. The settlement basis, in this instance, is a contract such as the following, which is similar to that in use at some of the Western selective-flotation plants:

Payments

Gold—Pay for 65 per cent if over 0.01 oz. per ton, at $19 per ounce.

Silver—Pay for 65 per cent at the New York price, as quoted in *Engineering and Mining Journal*. No payment if silver content is less than 1 oz. per ton.

Lead—Pay for 65 per cent (assay to be wet less 1.5 per cent) if over 3 per cent, at the *Engineering and Mining Journal* quotation for New York lead, less 2c. per pound.

Copper—Add to lead assay and pay for as lead.

Zinc—Pay for 65 per cent if 6 per cent or over, at 40 per cent of the *Engineering and Mining Journal* quotation for Prime Western zinc at East St. Louis.

Settlement prices for silver, lead, and zinc to be based on the average weekly quotation as published in *Engineering and Mining Journal* for week ending Wednesday preceding date of sampling.

Charges

A base milling charge of $4 per ton of ore.

With a contract similar to the above, only two variables exist for each metallic constituent of value in the ore—the content of metal in the ore and the unit price of that metal. Contracts of this nature vary widely in wording and specification, but all will lend themselves to a graphic solution if the number of variables is not increased. The scale on which the graph is reproduced controls the degree of accuracy that may be secured. The larger the scale, the more nearly accurate will be the reading. Knowing the metallic content of the ore and the prevailing prices for the metals under consideration, the solution involves only the use of a straight-edge, the addition of four small numbers, and the subtraction of a constant figure from their sum.

To illustrate the use of the chart, the following example is given:

Analysis of ore—gold, 0.05 oz. per ton; silver, 12.5 oz. per ton; lead, 6 per cent (adjusted assay); zinc, 9 per cent. Metal prices—silver, 60c. per ounce; lead, 6c. per pound; zinc, 6.5c. per pound. Using a straight-edge, the value of 0.05 oz. gold is determined by finding the intersection of the vertical line representing a content of 0.05 oz. gold per ton with the solid diagonal line representing gold at $19 per ounce. The point on this diagonal line is then projected horizontally onto the ordinate where the value in dollars and cents is ascertainable; in this instance the value is $0.62 per ton of ore.

The process is repeated for silver, the projective point

being directly above the 12.5 unit figure of the abscissa on the dot-and-dash diagonal line marked 60c. silver, reprojected onto the ordinate and the value of the silver content determined as $4.88 per ton of ore. Lead return is figured on a basis of 6 units at 6c. per pound and yields an additional return of $3.12; similarly, the net return for nine units of zinc at 6.5c. per pound, under the conditions of the contract, is $3.04. The sum of these four figures, less the base milling charge of $4, yields a net return at the plant of $7.66 per ton of ore. This is the figure with which the plant operator is concerned.

As the gold content of an ore of this type is invariably small in comparison with the silver, the arrangement of providing a special scale for the gold content is utilized. If desired, each metal content can be platted on a separate scale. The ranges of assays and analyses encountered are the controlling factors for any ore. From the results of laboratory tests, or previous runs on ores from the same or a similar source, the grade and quantity of concentrates to be secured and their ultimate return per ton of ore can be determined.

In practice, the analysis of an ore rarely will present the simple figures used in the foregoing example, nor will metal prices be consistently quoted at even figures or major fractions thereof, but with a large-scale graph the necessary interpolation will prove accurate to a surprising degree. The use of a chart of this nature is also of assistance in expediting calculations of the mine operator who mines an ore that is close to the dividing line between shipment under two or more contracts, as sometimes is obviously the situation with shippers of complex ores.

In practice, greater speed in the use of a chart of this nature may be had by constructing it with a strip of celluloid or pasteboard used as a straight-edge and pivoted at the origin. The upper and right-hand margin lines of the chart may then be utilized to carry a larger number of indicatory marks for the various "in-between" metal-price quotations, thus reducing the extent to which interpolation need be depended on, as well as facilitating and speeding up the manipulation, but without covering the face of the chart with a mass of small lines that are confusing to the eye. By the use of the pivoted straight-edge and a large-scale graph, calculations can be checked within a few cents of the results actually secured by long-hand methods or the use of an adding machine.

Metal Sheets That Are Transparent

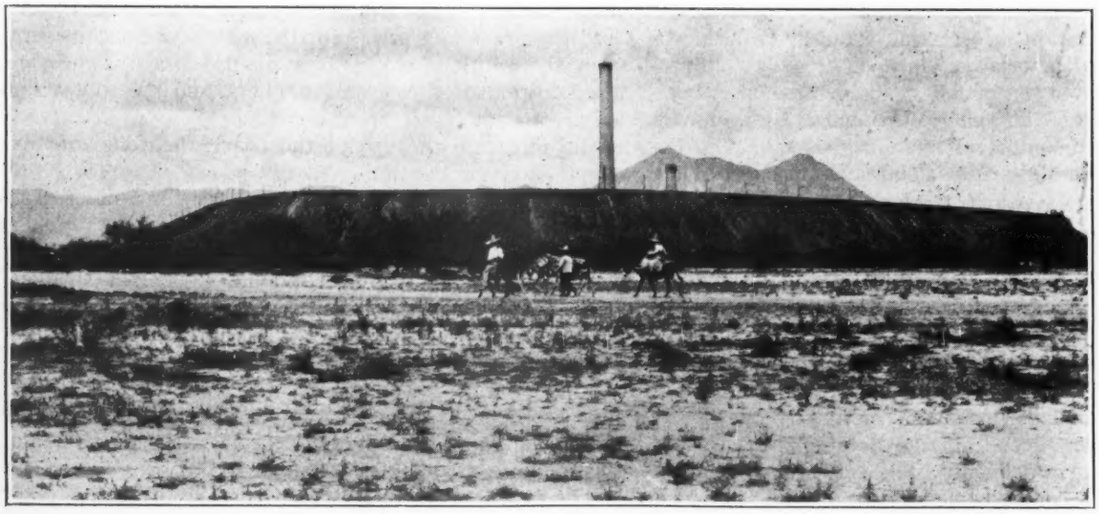
FROM the Charlottenburg Laboratory, Berlin, have come reports of the production of sheets of metal so thin that ordinary type can be read through them. The method employed is said to involve electroplating the metal on the surface of some soluble substance, such as rocksalt, which is then dissolved away. A ring of thicker metal can be used to support the films, of which two and a half million would have to be piled to make a stack an inch high. Films of this tenuity have been made of iron, nickel, gold, silver and platinum. The films are very elastic and will bulge out for as much as a tenth of their diameter without breaking. They may consequently find use in radio and photographic reproducers to replace the present diaphragms, which are so heavy that they coarsen sounds by dampening the overtones. The *Industrial Bulletin* of Arthur D. Little, Inc., from which this information is gleaned, makes no mention, however, of the adoption of these metal sheets as a dress fabric.

As the films are practically all surface, they possess very high electrical conductivity. A strip of film containing no more metal than round wire one-hundredth of a millimeter in diameter will carry enough current to light several lamps, whereas if the same current were sent through the wire the latter would be instantly melted.

Golf Course and Smelter

ONE would not think that a golf course was anywhere in the neighborhood of the smelter stack and slag dump shown in the accompanying photograph, nor do the Mexicans appear ever to have heard of the game. And yet, it was on the sixth green of the golf course at the Matehuala plant of the American Smelting & Refining Company that this photograph was taken. Perhaps the Mexicans are hazards!

Incidentally, the stack appearing in the distance is said to be the tallest stack in Mexico. The smelter is equipped with four blast furnaces. At the base of the stack is the Cottrell plant, the dust from which, high in arsenic and lead, is shipped to the arsenic plant at San Luis Potosi. The La Paz silver mine is on the left-hand side of the mountain in the background. The face of the slag dump is very steep, a condition common to high lime-alumina-zinc, and low iron slags.



The sixth green of the golf course at Matehuala

The Old Dominion Company

Part XIV:

Revisiting Arizona Mining Camps

By E. H. Robie
Associate Editor

SIX miles east of Miami is the town of Globe, which now boasts of but two copper-producing companies, the Old Dominion and the Arizona Commercial, the first named being about 60 per cent owned by the Phelps Dodge Corporation. The New Dominion company was shut down two or three years ago, though a part of the mine was subsequently leased, and has made an occasional shipment of lead carbonate ore. The Iron Cap property ran out of ore within the last year or two, and productive operations were transferred to the Christmas mine, mentioned in a preceding article in this series. Superior & Boston, operating at the eastern end of the vein systems mined by the other companies, has finally given up the ghost after a long search for ore, financed by occasional Irish dividends. Until recently, enough ore was always in sight to act as a spur for further development.

THE Old Dominion, of course, is a historic mine, using the adjective with regard to the comparative age of other producing mines in this country of ours. It first came into prominence fifty years ago. Reminiscences of the early days were most interestingly related by Professor Walker in the April 14 and 28 issues of *E. & M. J.*, which I recommend for perusal in an idle hour. About the same time, the Homestake, in Dakota (there was no North and South then), came to the producing stage, and Butte, also, though the first claim in Butte was patented in 1864. Michigan copper production dates back a little further—around 1850—at about the same time that the Tennessee deposits began to be exploited. This, however, is no history of the copper industry, and I mention the matter here only because of calling attention to the fact that Globe is an old camp. Recently it has changed but little. Though automobiles are more common, the wide main street of the town affords ample room for them; the Old Dominion—mine and hotel—still stand supreme, only the hotel, of course, omits the Old.

W. G. McBride, for ten years general manager of the Old Dominion, resigned last year to become professor of mining at McGill University, his place being taken by I. H. Barkdoll, formerly mine superintendent. My talk with Mr. Barkdoll was brief, but he seems well fitted to uphold the traditions of the company, and perhaps will be successful in bringing the company back among the dividend payers, where it has not been for many years. The company, however, is essentially a high-cost producer. The "A" shaft is now down to the 27th level, mining of the veins at depth being complicated by a large flow of water. About 1,000 tons of ore a day is produced, containing about 3½ per cent of copper as chalcocite and chalcopyrite, with pyrite and highly siliceous gangue. Development of ore between the 22nd and 26th levels has been disappointing for the last two years, and ore reserves have declined, though it has never been the policy to keep ground open very far ahead. The mine seems likely to produce for many years yet, particularly if copper prices move a little higher.

The Old Dominion mill treats both the ore from the company's mine and that from the Arizona Commercial. D. L. Forrester is the mill superintendent. His name has become familiar to flotation operators all over the world in recent years through his development to a commercial success of the type of flotation machine employing free admittance of air through large pipes with their outlets near the bottom of a launder or vessel containing the pulp. Machines of this type have been widely adopted by the Phelps Dodge company and by several other operators. Generally speaking, their upkeep cost is exceedingly small, owing to their simplicity, and their power cost per cubic foot of air compressed is also low, on account of the low pressure required. On the other hand, the free outlet results in somewhat more air being consumed than when the air is released through a porous mat. I regret that I cannot at this time give any explicit information regarding the construction or operation of this cell, as these matters, unfortunately, are to be aired in the courts. A real advance in technology often results in litigation, particularly, it would seem, when that advance is in the realm of concentrating ore by the flotation process.

A CONSIDERABLE sum has been spent in the last year or two in modernizing the Old Dominion mill, the crushing department having been revamped and the flow sheet revised, with the installation of the Forrester machines. A higher-grade concentrate and lower tailing resulted last year, and further improvement is being made in current practice. A few comparative metallurgical statistics follow:

Old Dominion Concentrator Data

	1926	1927
Per cent copper in feed	4.01	3.49
Per cent copper in concentrate	19.45	21.10
Per cent copper in tailing	0.31	0.27
Ratio of concentration	5.23:1	6.52:1

Reagents used at the Old Dominion are not constant, of course, but the following are representative of the practice early this year: 6 to 8 lb. of lime per ton; 0.07 lb. of xanthate; 0.25 to 0.15 lb. of pine oil; and 0.08 to 0.1 lb. of reconstructed oil. This reconstructed oil is a home-made sulphidized product, made by adding 5 per cent of sulphur to blast-furnace oil, or Barrett No. 4, and heating. Xanthate alone does not produce a sufficiently tough froth.

IN speaking of the Newhouse gyratory crusher at the Miami concentrator, in the July 21 issue, I mentioned the fact that the cone of this crusher revolved in one direction when the machine was not loaded, and in the opposite direction when ore was being crushed, admitting my ignorance of the reason thereof. Mr. Newhouse explains the matter in a letter published on page 264 of this issue. I suspect that, though many of my readers have probably noticed this action, few of them have understood the reason any more than I did. Like the force of gravity before the time of Newton, it has been simply accepted without knowing why. I understand that this action has often been used in the design of self-tightening crusher heads, first in a patent issued to G. H. Thurston, April 2, 1907, No. 848,782. Mr. Newhouse himself has taken out a patent on a head-tightening device using this principle (No. 1,151,119, issued Oct. 24, 1915).

Problem of Cyaniding South Dakota "Blue Ores" Solved

METALLURGICAL methods which have proved successful in the treatment of the so-called "blue ores" of the Black Hills gold mining district, in South Dakota, heretofore not amenable to satisfactory treatment, are described in a report just issued by the U. S. Bureau of Mines, to which the problem was submitted by the mine operators of the district. The outstanding feature of the process developed by the Bureau provides for a maximum cyanide recovery of the precious metals associated with arsenic and antimony ore, by a low-temperature short-time roast. The process has also proved successful in the treatment of certain metallurgically difficult ores from the Manhattan (Nevada) gold and silver district.

The blue ores of the Black Hills mining district have presented a refractory gold problem for nearly half a century, state Edmund S. Leaver and Jesse A. Woolf, authors of the report. In the higher central area of the northern Black Hills there is a flat formation of Cambrian limestone and shales supported by underlying quartzite. At the horizon where the ore occurs the original rock appears as dolomitic limestone, now partly replaced by silica carrying gold and a little pyrite. The unoxidized portion of the orebodies is commonly bluish, which accounts for the local term "blue ore," in contradistinction to the brown or oxidized ore.

A series of breaks or vertical fractures extending into or through the quartzite probably furnished the channels for the mineral-bearing solution to reach the soluble limestones where the mineralization extended laterally for an unknown distance. That is to say, the workings of the mined oxidized ores occur in and adjacent to the fractures. The unoxidized blue ore that appears at the faces of these workings has not been extensively prospected, except in the Commonwealth mine. Several mills were erected, which for a number of years treated a considerable tonnage of oxidized ore by a direct cyanide process, with the recovery of about 75 per cent of the gold. All of these mills were later shut down.

Preliminary work in this investigation was conducted at the Bureau of Mines Rare and Precious Metals Experiment Station, at Reno, Nev. On the basis of results at Reno, a demonstration plant of one-ton daily capacity was installed at the South Dakota State School of Mines at Rapid City. The findings of the investigation are summarized in Technical Paper 423 as follows:

"The work shows what to expect with cyanide treatment in cold and in hot solutions and the effect of roasting at various temperatures.

"The outstanding feature indicating maximum cyanide recovery of precious metals associated with arsenic and antimony ore is the proposed low-temperature short-time roast, approximately 30 minutes at 450 deg. C.

"The ordinary high-temperature roast (600 deg. C. and above) results in the formation of arsenates and antimonates which lock up gold and silver in such a manner that this part of the contained gold and silver is not soluble in cyanide solution. Moreover, the roasting of silver ores at 600 deg. C. or above forms some silver-silica.

"At a temperature of approximately 450 deg. C. for a relatively short time it is practicable to dissociate the arsenic or antimony minerals, so that the contained silver and gold in the resultant calcine are almost completely soluble in cyanide.

"Direct cyanide treatment of the calcine from the low-temperature roast would result in excessive loss of cyanide and corresponding fouling of solution. Both these conditions are corrected by the addition of lime before cyanide treatment. The lime may be added as a preliminary wash or added to the calcine, moistened with 10 per cent water, and then allowed to stand three days or longer before treatment with cyanide.

"To study the action of arsenic and antimony minerals, experiments that paralleled ordinary cyanide-recovery methods were made with prepared chemical compounds of arsenic or antimony with different base metals combined in proportion similar to minerals and with gold added. Similar tests were made with pure arsenic and antimony silver minerals.

"Application of the principles brought out in this research is shown by several examples of proposed treatment methods for well-known precious-metal ores generally recognized as being refractory."

Full details of this investigation are given in Bureau of Mines Technical Paper 423, "Cyanide Extraction of Gold and Silver Associated With Arsenic and Antimony in Ores, With Especial Reference to Those in Nevada and South Dakota," copies of which may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C.; price, 15c.

C. B. Lakenan Interview

Continued from Page 245

that will be required to equip a property, the technical skill and engineering experience that will be called for, and the fact that production costs at first will be relatively high.

Nevertheless he says, "The region should by all means be investigated by American copper interests. Opportunity for American capital and American engineers is excellent. In the Congo, because of the fact that the Belgian government is a virtual partner in the business, the situation is different; but arrangements can be made for American companies to participate in the exploitation of the Rhodesian deposits. It will doubtless be expedient for operations to be conducted by companies organized in London, but the British need and want help." If I sense his feeling correctly, Mr. Lakenan believes that the entire Congo-Rhodesian region will some day be a leading contributor to the world's copper supply—but that the growth in demand will keep a step or two ahead of the increase in supply.

On the way to Cape Town Mr. Lakenan visited the big game region, Matopo Hills, where Cecil Rhodes is buried, and Victoria Falls, as well as the diamond mines at Kimberley and the gold mines of the Rand. "The main problem on the Rand," he says, "is stoping the relatively narrow reefs in such a way as to get the lowest cost per ounce of gold, which is not necessarily the lowest cost per ton of ore. The ascertainment of the most profitable stope width is by no means easy. Operations appear to be highly efficient, especially from a mechanical standpoint; but with the growing scarcity of labor, the increased heat at greater depths, and the added cost of handling and hoisting ore, I suspect that the peak of production has passed."

It is clear, however, that Mr. Lakenan's chief enthusiasm at the moment is for Rhodesia and copper. Perhaps it offers an outlet for his pioneering instincts; gives him an opportunity to do something new—possibly to get a new "child" to look after for a few years. At any rate he has, perhaps unwittingly, hinted that he is already laying plans to interest American associates and to go back as the British would say to "have another look."

USEFUL OPERATING IDEAS

Scraper for Conveyor Belts

By Guy H. Ruggles

IDEA No. 1

A RUBBER scraper for cleaning conveyor belts was devised and constructed early in 1920 by men working at the filter plant of the Inspiration Consolidated Copper Company. It has proved successful and satisfactory in every way. Details of design are given in the accompanying sketch.

The scraper shown in the illustration was 18 in. wide and was used with a 20-in. belt. It consisted of a piece, 1 in. thick, of U. S. Rubber Company's No. 700 stock or its equivalent, held between angle iron clamps as shown. At present a 24-in. belt is being used with a scraper 22 in. wide. The thickness of the rubber has also been increased from 1 in. to 1⅛ in. The rubber is fairly hard, of the same consistency apparently as the outer rubber in an automobile tire casing.

Springs are provided to hold the scraper against the belt surface. The compression of these springs is controlled by the wing nuts at the end. As the scraper wears, it is necessary to reset it occasionally between the angle irons.

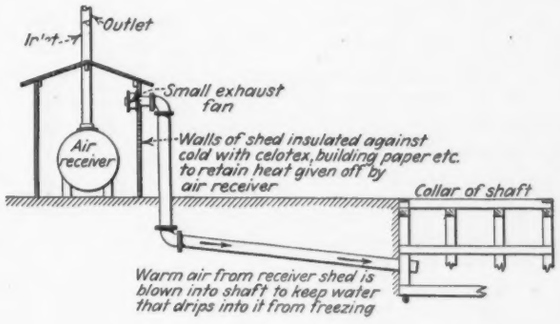
The belt upon which the scraper is used is handling flotation concentrate, the moisture of which has varied from 20 to 8 per cent over a period of years. The stickiness of the concentrate has also varied, depending on the insoluble content. A scraper on this belt has always been necessary. Originally very heavy elevator belting was used for the scraper, and the wear on it amounted to about 1 in. in four days. When the rubber scraper was installed the wear was reduced to 1 in. in sixteen days. At that time the belt was traveling 150 ft. per minute. Since then this speed has been reduced to 50 ft. per minute, with a reduction in wear on the scraper to about 2 in. per year. The scraper made of elevator belting originally used undoubtedly held fine concentrate in its plies and caused heavy wear, both on itself and on the conveyor belt.

Credit for the development of this device should also be given to representatives of the United States Rubber Company, including Gordon R. Kyle.

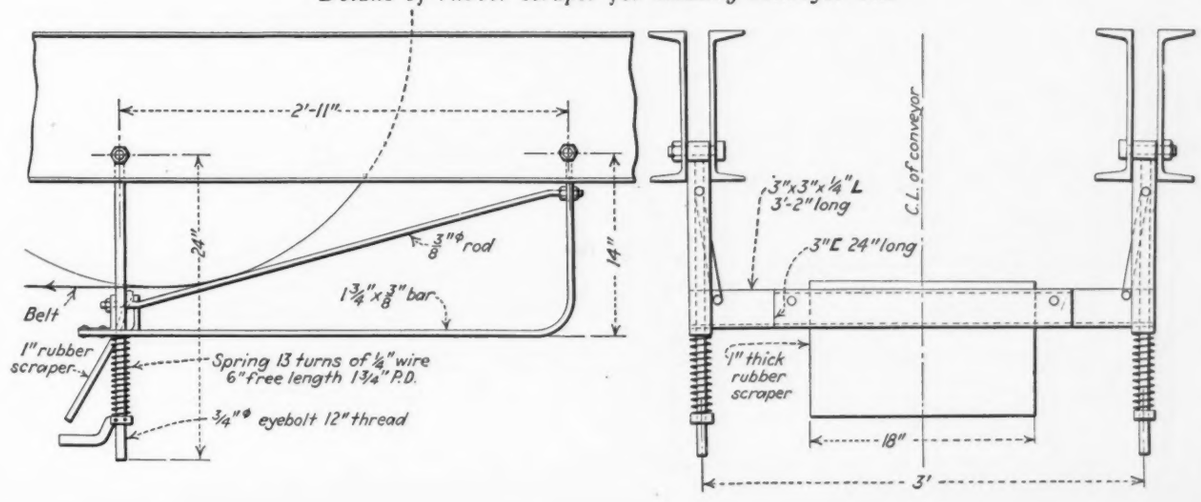
Simple Arrangement Utilizes Heat from Air Receiver

IDEA No. 2

IN COLD CLIMATES it is customary to expect trouble as a result of the freezing of water around the collar of the shaft. This has been avoided at the Wright-Hargreaves property, at Kirkland Lake, Ont., by an ingenious utilization of the heat given off by an air receiver, which is housed in a small building with insulated walls. Near the roof an exit with exhaust fan is provided for connection to a ventilating pipe delivering to the shaft, as shown in the sketch.


Outlet
Inlet
Small exhaust fan
Air receiver
Walls of shed insulated against cold with celotex, building paper etc. to retain heat given off by air receiver
Collar of shaft
Warm air from receiver shed is blown into shaft to keep water that drips into it from freezing

Details of rubber scraper for cleaning conveyor belt

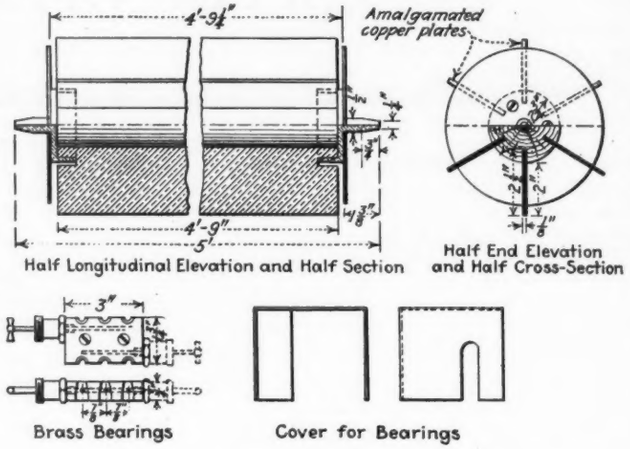


A Revolving Splash Plate for Amalgamating

IDEA No. 3

DETAILS of stamp milling practice at the Mysore gold mine, India, are given in a paper by F. W. Kendall in Bulletin No. 21 of the Kolar Goldfield Mining and Metallurgical Society (reprinted in the February *Mining Magazine*). In the course of experimenting with a view to increasing the percentage of recovery by amalgamation, a revolving splash plate was devised for the purpose of breaking up the pulp from the battery before it reached the first amalgamating table. This revolving plate is shown in the accompanying illustration. The details of its construction are as follows:

The apparatus consists of a solid wooden drum, 5 ft. long by 2¾ in. diameter, with six grooves equally spaced the length of the drum, into which are fitted six amalgamated copper plates or vanes, 4 ft. 9 in. long, 2½ in. wide, and ⅛ in. thick (the width outside the groove being 2 in.). At each end of the drum there is an iron cap with spindle, 1⅜ in. long, ½ in. diameter, tapering to ¼-in., the taper length being ¾ in. Affixed to each side of the table are two pieces of brass, 3x1¾x¾ in., in which 6-in. bearings have been machined for the spindles, thus making it easy to replace a worn bearing. The bearings have a zinc cover. The splash plate revolves at a speed of from 30 to 40 r.p.m. Momentum is given to it by the discharge of pulp from the screen, working similarly to a water wheel. The drum naturally revolves in the opposite direction to the flow of the pulp down the table. The initial weight of the apparatus is 52½ lb., which is increased by the adhering amalgam. The advantages claimed for this type of splash plate are that it beats into the discharged pulp, which flows on to the apron plate in an even stream. The vanes being always clean after discharging the pulp, clean surfaces of amalgamated copper are in consequence always coming into contact with the freshly discharged pulp from the screens. In this experiment the value of the minus 200 product was decreased by 10 grains (22 grains against 32 grains).



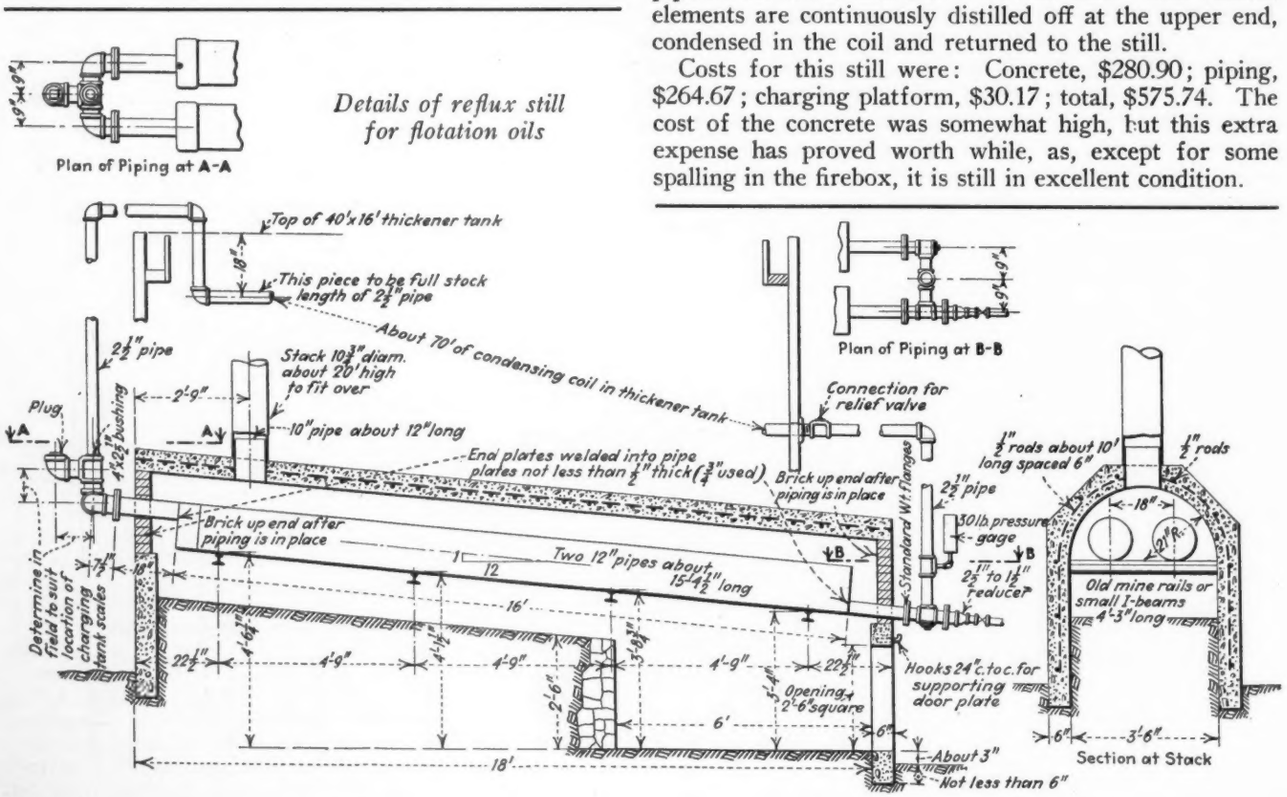
Reflux Still for Flotation Oils

BY E. H. ONEAL

IDEA No. 4

FOR the preparation of flotation chemicals the reflux still shown in the accompanying drawing was built by the Old Dominion company and has given satisfactory service for the last six years. It consists of a reinforced-concrete furnace, two 12-in. pipe retorts, and a condensing coil. The end arch openings are of brick, laid after the pipe was in place. This allows for easy removal in case of repairs to the piping. The still is charged through the 4-in. pipe at the upper end by removal of the plug, and is emptied through the 1½-in. pipe at the lower end into a service tank. The volatile elements are continuously distilled off at the upper end, condensed in the coil and returned to the still.

Costs for this still were: Concrete, $280.90; piping, $264.67; charging platform, $30.17; total, $575.74. The cost of the concrete was somewhat high, but this extra expense has proved worth while, as, except for some spalling in the firebox, it is still in excellent condition.


Plan of Piping at A-A
Top of 40'x16' thickener tank
This piece to be full stock length of 2½" pipe
About 70' of condensing coil in thickener tank
2½" pipe
Stack 10¾" diam. about 20' high to fit over
Plug
2'-9"
10" pipe about 12" long
End plates welded into pipe plates not less than ½" thick (¾" used)
Brick up end after piping is in place
Two 12" pipes about 15'-4½" long
Determine in field to suit location of charging tank scales
16'
18'
4'-9"
Opening 2'-6" square
6'
About 3"
Not less than 6"
Plan of Piping at B-B
Connection for relief valve
Standard Wt. flanges
2½" pipe
30 lb. pressure gage
2½" to 1½" reducer
½" rods about 10' long spaced 6"
½" rods
Old mine rails or small I-beams 4'-3" long
Hooks 24" c. to c. for supporting door plate
Section at Stack

Details of reflux still for flotation oils

COMMENT AND CRITICISM

Californian Mining Industry Not Dead

THE EDITOR:

Sir—In your issue of July 21, under the caption of "Blue-Sky Legislation," the writer from Grass Valley, Calif., gives approval to the decisions of the State Corporation Commissioner in regard to mining promotions. His remarks on this subject are just, for the commissioner does not prevent but assists legitimate mining and prospecting ventures. But the writer's remarks on California as a metal-mining state are open to criticism. He states briefly that mining in California is a thing of the past, but refers to the Walker copper mine and the Empire and North Star gold mines as exceptions. He forgets the Kennedy, Argonaut, and Central Eureka gold mines, on the Mother Lode, the important placers of the Yuba Consolidated and Natomas, and Engels Copper, which produced up to the end of 1926 over 121,000,000 lb. of copper.

The Kennedy gold mine is the deepest gold mine in North America, with good ore in the bottom and with strong fissures that will surely extend to a vertical depth of 6,000 ft. or deeper. In 1927 California produced gold to the value of $11,671,018; silver worth $918,677; and 27,133,008 lb. of copper.

In regard to the possibility of the discovery of new deposits of importance, attention might be called to the California Rand Silver mine, which was discovered in 1919 and in four years produced gold and silver valued at more than $10,000,000. This property, situated in the heart of the Randsburg mining district, had been walked over by hundreds of mining men and prospectors before the deposits lying underneath were discovered. In the desert regions of southern California it is likely that other important metallic deposits await discovery, and deeper mining on the Mother Lode will probably prove up orebodies in depth at present unknown.

San Francisco. HENRY W. TURNER.

THE EDITOR:

Sir—In defense of the blue-sky commission of California, a correspondent in the July 21 issue of *E.&M.J.* has felt himself called upon to advertise to the world that California—outside of Grass Valley, the correspondent's bailiwick—no longer holds any attractions to the industry that has added so much to its prosperity.

Personally, I lay no claim to technical training in the mining game; however, for many years I have been a subscriber and avidious reader of the *E.&M.J.*, and by process of absorption have gained at least a smattering of the science that your journal so ably presents week by week to its many expectant readers. I have lived in California fifty years, during which periods I have been and am now, in a modest way, endeavoring to find a little gold that Mr. Snyder says is *non est* except in Grass Valley.

It is true that six years ago the condition of the big silver mine of this county would, perhaps, have been a silent affirmation of Mr. Snyder's rash and pessimistic viewpoint of California decadence in the precious metal industry outside of Grass Valley. Since that time, however, by application of a little capital and much nerve and foresight, this then hidden treasure vault has added millions of the white metal to the wealth of the country.

If our pessimistic friend will, for a brief period, crawl out of the tall grass of his favored valley, and look upon the vast spaces of the Mojave and Colorado deserts, he will conclude that, to paraphrase Shakespeare, there are more things,—gold, silver, lead, copper and zinc,—in California than are dreamt of in his philosophy.

The blue-sky commission needs no such defense. The law by which it functions is one of the commendable laws of this state, protecting not only the investor, but lending its support to all legitimate business so long as it is conducted in such manner as to assure fairness to all.

Had Mr. Snyder attributed the low ebb of mining in California to a loss of interest of present-day capital compared to that manifested by the old-time mining man, who was not only willing to take a chance himself, but was willing that the discoverer and developer of a promising prospect should also have a chance, then the riddle of the quietness in the hills and upon the desert waste would be solved. Then the sophism issuing from the tall grass of the one favored spot in the vastness of our great state would be dispelled; and the mountains that stood in the old days, in their grandeur, would be productive of other "Walkers," "Empires," and "North Stars." Those behind these outstanding properties are no laggards in the expenditure of money to keep them on an even keel—with further days of productiveness and prosperity in prospect.

JOHN L. CAMPBELL.

San Bernardino, Calif.

Some Early Scientific Investigations

THE EDITOR:

Sir—Discussion of the effectiveness of mineral and water indicators comes up as regularly as decades on the calendar of time. Your issues of July 7 and 21, reviving the discussion of Mr. Rickard's paper, recall to me a little ancient history, a history dating back to 1874, at which time I did not know the difference between an igneous and sedimentary formation, but was curiously if not scientifically interested in picking fossils from the slate or shale sedimentaries on the shore of Lake Erie. At that time I was employed as a telegraph operator at the Bay View Hotel, 15 or 20 miles east of Buffalo. Though we were on the shore of the lake, it was advisable to sink a well near by rather than to pump water from the lake.

One day I received a telegram addressed to Mr. Latour, the manager of the hotel, stating that a scientific expert in water-finding would arrive at the hotel that evening. Being a novice then, as now, in scientific matters, and yet inquisitive, I was interested, so I accompanied the manager and the "water expert" on their trip of investigation.

The expert arrived equipped with a forked witch-hazel stick. We walked over the ground, the stick bobbing at certain points. It was desirable to have the water as near the hotel as possible; therefore, the expert accommodatingly located his biggest find near the kitchen, and to verify his claim, handed the bobber to Mr. Latour and then to me. The harder I held the forked ends, the more determined the thing was to change position. I took occasion to peg the spots as located, but unknown to the expert, as the experiments were to be gone over next morning (free hotel accommodations being the expert's fee). The following morning the expert located one or two other convenient points, and I suggested that we return to a point a little nearer to the kitchen—in fact the point where, on the evening previous, he had found the water in "plentiful supply." A trial was made, with the result that the expert stated, "No water here." But "here" the well was located and never failed in supply. Looking backward, I realize that any old place within a mile or more was probably saturated with ground water.

After the expert's departure I called Mr. Latour's attention to the locations that had been given the previous evening, which did not always coincide with those of the morning. Mr. Latour,

in the meantime, had become a little skeptical, even in spite of the fact that the expert had passed to him his forked stick, and endeavored to prove his claim by instructing that it be held tightly. The stronger the grip, the more sure it was to go out of balance from the perpendicular. Later in the day we cut forked willow twigs similar to the expert's witch-hazel bobber, and it was not long before Mr. Latour and myself demonstrated the fact that the harder one would hold the forked stick, the surer it was to go out of balance. This action of the stick has been described by Mr. Holder in his remarks on the divining rod, and confirms the opinion that I have always held that this old yet modern fake owed its action to muscular-nervous action on the part of the operator.

This bobber fake recalls another experience I had in Cobalt, Ontario, in 1906, when Ontario was young in metal mining. In this case the "diviner" appeared with a bobber in the form of a string attached to the end of a rod, and from the end of the string a metal similar to the one sought was suspended. The metal on the end of the string was supposed to swing along the trend of the exposed or hidden vein. Here again I got myself in conflict with Mr. Expert by taking my eyeglasses attached to a light cord, held the cord at arm's length, and evidently without any physical movement on my part and without lowering my arm, made the glasses swing and change direction at will, either in circles or straight lines.

To the skeptic I say, try either of the above-mentioned experiments. Any old forked stick or any old material hung suspended can fool the observer, as surely as does the sleight-of-hand performer fool his audience.

My remarks must not be confounded with the detection of earth currents hovering around mineral bodies, as any surveyor will testify. I recall an instance at Dos Cabosos, N. M., where the mineral earth magnetism was so strong that it turned my compass needle nearly 45 deg. out of polar line.

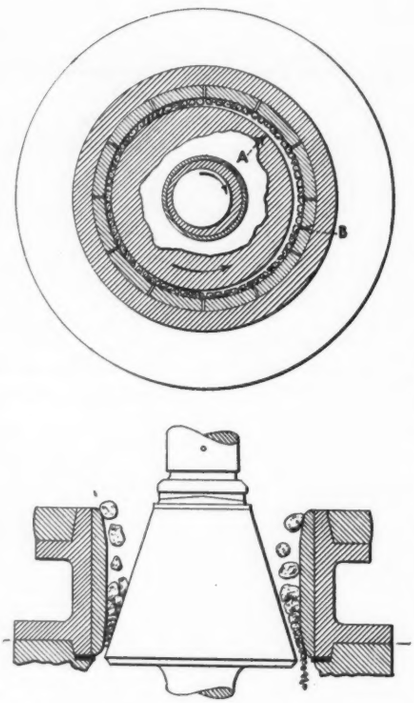
New York City. H. W. HARDINGE.

The Action of a Gyratory Cone

THE EDITOR:

Sir—In an article regarding the Miami Copper concentrator in the July 21 issue of the *Engineering and Mining Journal,* E. H. Robie refers to the fact that the cone in the Newhouse crusher, when running light, makes 10 or 12 r.p.m. in the same direction as the motor, but when loaded the cone goes in the opposite direction. The rotation of the crusher head in the direction of rotation of the eccentric is due to the viscosity of the oil, tending to make the crusher shaft rotate with the eccentric. The rotation of the head in the opposite direction under load does not seem to be so well understood, although it is present in all gyratory crushers.

The accompanying sketch shows a section through the crushing chamber of a gyratory crusher with the eccentric



Sectional view of the head of a gyratory crusher

showing below. The crusher head is, of course, at all times off center, with the center of the head following a circular line around the axis of the crusher.

The line of the greatest pressure between the head and the stone is at that point where the distance between the head and the outer shell is least. The circumference of the head is indicated by the line "A." The circle of the greatest pressure contact is indicated by the line "B." When the crusher is filled with stone the head rolls on the circumference of a circle having a greater diameter than that of the head. Therefore, it follows that the head is turned in a direction opposite to that of the eccentric. This principle has been used in making speed reducers, where an eccentric is used to actuate a pinion secured against rotation, but forced to gyrate in contact with the teeth of an internal gear. This causes the internal gear to rotate at a much lower speed than the speed of the eccentric.

The higher speed of rotation of the head in the Newhouse crusher is due first to the high eccentric speed, and second to the fact that in this crusher the eccentric moves the head so fast that the acceleration of the stone, due to gravity, is not equal to the speed of travel of the crusher head. This causes an actual opening between the stone and the head on the open side of the crusher, so that the head is more free to turn than in the previous gyratory crushers where the speed is so slow that the stone by gravity follows the receding motion of the crusher head. So far as is known the Newhouse crusher is the first crusher in which this principle has been used.

R. C. NEWHOUSE,
Chief Engineer, Crushing and Cement Machinery Division, Allis-Chalmers Manufacturing Company.
Milwaukee.

Determination of Classifier and Screen Efficiency

THE EDITOR:

Sir—I have read your editorial on "Simple Determination of Classifier Efficiency" in the issue of July 21. It has appealed to me that classifier efficiency cannot be determined by screen sizing tests. Sometimes comparative performance of classifiers operating on the same feed can be elucidated by screen sizing tests. But when we determine the efficiency of screening of a screen, we compare it with the most perfect screening it is possible to do on the given feed. And in like manner, it seems to me, classifier efficiency should be determined by comparison with the best and most accurate classification experimentally possible. Ores contain heavy and light minerals. A small heavy particle can very properly be classified with a much larger light particle without prejudice to the real efficiency of the classifier.

Most of us will agree that grinding mills and classifiers are installed for the purpose of securing the greatest liberation of economic mineral. In these days of selective flotation it may easily be that proper liberation from gangue minerals occurs at a relatively coarse size, whereas liberation of the associated sulphides may require very much finer grinding. It is obviously uneconomic to reduce the gangue to the same degree as the sulphides. The *efficiency of liberation* will depend in no small degree on the choice of classifier, but it is very clear that mere screen analyses alone of classifier products on one ore are not comparable to those of another different ore.

It is well to differentiate classifier efficiency and efficiency of liberation.

ORE DRESSER.

Canada.

[Manifestly, any numerical expression for classifier efficiency based on screen tests of the feed and the resulting products is relative rather than absolute. At the same time, if an attempt is to be made to arrive at a method for calculating and expressing efficiency, some standard must be fixed as a basis for perfect work; and this logically may be complete separation at a prescribed mesh. If the "best and most accurate classification experimentally possible" is used as standard, serious complications are introduced. The statement that the purpose of grinding and classification—the latter being in a sense a phase of the entire comminuting operation—is to

"secure the greatest liberation of economic mineral" is not true. Strictly speaking, the purpose is to liberate as much of the marketable mineral as can be without increasing the cost of operations to such an extent that the net profit is decreased. Our correspondent draws attention to a parallel problem when he states that ". . . when we determine the efficiency of screening of a screen, we compare it with the most perfect screening possible to do on a given feed." This statement prompts a brief discussion and some comments on the generally accepted definition of screen efficiency.

"It will be realized," states Professor Truscott on p. 245 of "Text Book of Ore Dressing," "that applying this expression [the formula developed from the Hancock theory] to screen sizing, where the whole of the oversize, 100 per cent, must of necessity be in the coarse product, the efficiency of screen sizing . . . is represented by the bulk percentage of undersize in the fine product."

The reservation introduces a complication, and one may be permitted to take exception to the assumption that a screen must always deflect the whole of the determined oversize into the proper channel. Accidents happen; screens do wear and they occasionally break. In such event, is the modified method applicable?

Professor Truscott summarizes the customary viewpoint when he says (on p. 246) that "The efficiency of a screening appliance is measured by the ratio between the weight of obtained undersize and the weight of undersize determined by sizing analysis to exist; it is usually expressed as a percentage. By making sizing analyses of the feed and of the oversize—using a sieve having the same aperture as the machine—it is not actually necessary to trouble about these weights, as the efficiency can be calculated without them. Thus: Assuming, for example, the feed to consist of 25 per cent oversize and 75 per cent undersize, and the resultant oversize to contain 25 per cent undersize; then from 100 tons of feed the 25 tons of real oversize would be accompanied by 8.3 tons of undersize; and of the original 75 tons of undersize, 66.7 tons, or 88.8 per cent, would have been separated. The sizing efficiency in this case would therefore be 88.8 per cent."

If a sieve is used having the same aperture as the machine, it is obvious that its apertures must vary, or it must be subjected to the same wear as the machine. The efficiency figure will, therefore, have no uniform basis.

This customary method of computation is open to criticism. The amount of oversize in the coarse product, expressed as a percentage of the amount of oversize in the feed, would remain 100 so long as the screen remained in its original state and intact. The method of calculating efficency, therefore, does not credit screen sizing with a high efficiency, under intact- or unworn-screen operation, in preventing the inclusion of any oversize in the finer product. It gives the efficiency of separation of the undersize; it does not give the efficiency of sizing.

The inflexibility of this method of computation will be appreciated by a hypothetical example. Assume a screen operating as described and at an efficiency, according to the accepted definition, of 88.8 per cent. Assume, moreover, the breaking of a portion of the screen, or wear of the wires, thereby allowing some oversize to pass through. A millman would consider that the result is less efficient. The formula would indicate an improvement. If a hole in the screen became so large that all the feed passed through, the efficiency calculated by the method under criticism would have been raised thereby to 100.

The efficiency of screening or classification should indicate the combined result of two or more separations; it does not seem logical to base it on the separation of the undersize or the separation of the oversize, alone. Moreover, standard-screen analyses, above and below the desired point of separation, would appear necessary to determine a screening efficiency that would have a bearing on predetermined requirements.—EDITOR.]

As Constant as the Northern Star

THE EDITOR:

Sir—Latins, I am told, are a demonstrative folk. To this rule the Mexican brigand is the proverbial exception. He prefers to present a stolid and sometimes even callous exterior to his contemporaries, that he may the better hide the true nature of his feelings. As a matter of fact, in a world which is all too prone to underestimate the intrinsic worth of the professional man, the Mexican bandit is almost alone in his admiration for the American mining engineer.

Instead of resorting to the more usual means of flattery and adulation, however, he pays his touching little tribute by kidnapping the object of his affections. In the past I have been deceived by his actions and, in common with an incautious world, I have judged him hastily and unjustly. But the most recent escapade in which both he and mining engineers were involved, that of Messrs. Mitchell and Hooper, has opened my eyes to the truth. What other reason can explain the constancy of his attentions than that he appreciates the worth and enjoys the company of his victims? When next I read in the daily press of the inordinate demands made by Mexican bandits for the release of captive American engineers, there will be no righteous indignation on my part. Rather, I shall smile on this additional testimonial of an admiration that has endured the test of time and wonder at the lack of comprehension possessed and so frequently displayed by my fellows.

PSYCHOLOGIST.

New York City.

Xanthate and Its Variations

THE EDITOR:

Sir—It is with great interest that I have read Mr. Stevens' reply to my letter which appeared in the June 30, 1928, issue of *Engineering and Mining Journal.*

Mr. Stevens deserves great credit for having discovered "Raconite," which from all accounts is a distinct improvement over the ethyl xanthates.

Following Mr. Stevens' letter, I referred to U. S. Patent No. 1,594,858. (I presume that this is the correct number, for I find that No. 1,594,859, as published in Mr. Stevens' letter, is foreign to flotation, and evidently an erroneous reference.) I referred also to U. S. Patent No. 1,525,211, issued to Mr. Stevens and filed on the same date as No. 1,594,858. I was impressed by the fact that Mr. Stevens was not sure at the time of his application for these patents as to the nature of the reagent he wished to cover. On page 2, lines 57 to 74, of patent No. 1,525,211, Mr. Stevens states:

"I am not certain what chemical reaction takes place . . . nor what is the exact formula of the compound or compounds obtained. However, the molecular proportions of the various components used, and a possible formula of the reaction product, may be indicated by means of the equation, assuming caustic potash as the alkali used—

$$C_nH_{2n} + 10H + (CS_2)_m + KOH = KO(C_nH_{2n}+1)(CS_2)_m + H_2O$$

in which n may be any number from 3 to 6 inclusive and m may be 1, 2, or 3 or possibly a higher number, depending on the proportion of carbon bisulphide to the higher alcohol used."

As far as is known today, no compound of a mono alcohol, carbon disulphide, and alkali is known in which the molecular proportions are other than 1:1:1.

Addition of excess carbon disulphide (or bisulphide) alone results in loss of the substance by evaporation; the addition of excess carbon disulphide with excess alkali results in the formation of trithiocarbonates of the formula CS_3M_2 (where M is a monovalent metal), whose value in flotation is not known and probably is nil.

A. M. GAUDIN

Associate professor of metallurgical research, University of Utah.

Salt Lake City.

[Guggenheim Brothers, at their New York laboratory, have had research men at work for some time on flotation reagents. They have been successful in devising a variation of xanthate that has been particularly successful at Braden, where the recovery was raised, last year, to 85.25 per cent, compared with 81.46 per cent in 1926, largely, it is understood, through its use. Particulars regarding these "higher" forms of xanthate would be interesting.—THE EDITOR.]

INDUSTRIAL PROGRESS

New Midget Electric Locomotives Solve Sublevel Haulage Problem

Midget locomotive drawing three five-ton capacity ore cars used on the Ontario tunnel haulage line

By H. D. Keiser
Assistant Editor

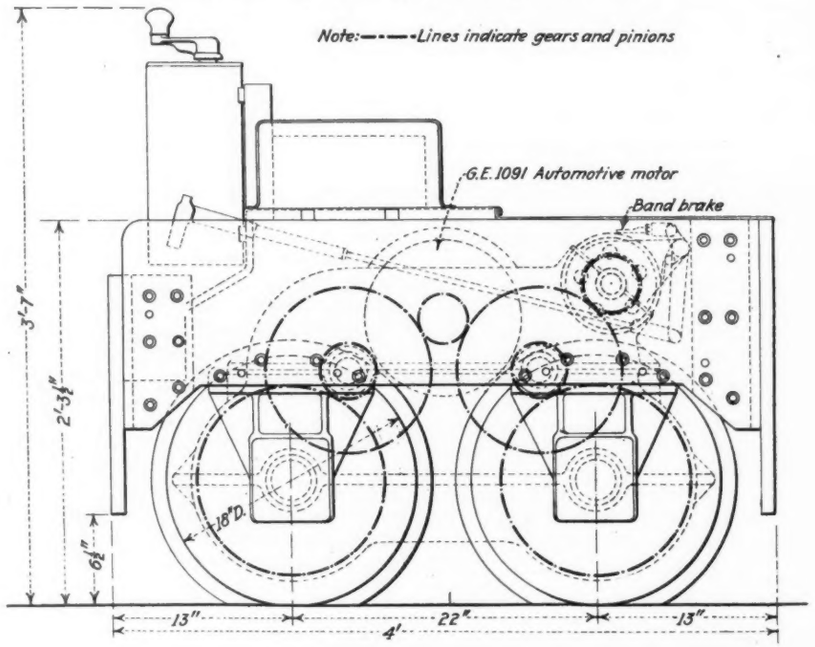
MINE haulage through narrow drifts and tunnels, where 18-in. gage track is used, presents a complex problem to the management of a property. Many methods may be employed, but for any one mine a combination must be selected that is suitable for the particular haulage requirements involved. The method developed at the Park City, Utah, properties of the Park Utah Consolidated Mines Company is an example of one solution of the problem, and a description of the features of this successful system is a subject of general interest.

Horses and mules were used at first on all haulage lines, and it was not until the ton-miles on any one haul exceeded the practical limit of animal haulage that electrification was undertaken. Electrification of the main haulage on one level led to the electrification of the remainder of that level and the subsequent elimination of animal haulage from that section of the mine. To meet the individual ton-mile requirements of the various hauls in a section, different types of locomotives had to be adopted.

Of the two main haulages, the first to be electrified was the Judge tunnel, which is 7,000 ft. long. Normal conditions prevailed here, and it was possible to employ the conventional four-ton trolley locomotive. The other main haulage, that through the Ontario tunnel, handles the tonnage of the Utah unit over a distance of 10,000 ft. It has a tonnage requirement of 1,000 tons a shift, although it is exceptionally narrow and is constantly used as a passageway by workmen. For this haulage a combination was adopted that provided complete safety to the men and a maximum tonnage capacity. The equipment comprises a double trolley wire, without connection to the rail or ground, and a special Westinghouse-Baldwin tandem locomotive of eight tons' total weight. This unit hauls a load of 80 to 100 tons of ore, and makes twelve round trips in one shift. The double trolley wire, which carries 265 volts between wires, has been in operation for five years and has proved entirely satisfactory. The distance between the positive and negative wires is only 4½ in., and consequently there is no danger of shock. Complete safety of the system has been demonstrated during the five-year period that this line has been in operation.

Electrification of the adjacent levels, above and below the main tunnel levels, presented another phase of the general problem. Ton-mile requirements were in excess of the capacity of a cage-type storage-battery unit, but a compact unit with safety against possible shock was a necessity. A trial was made of midget trolley locomotives that used a double trolley with 110 volts between wires and no connection to ground or rail. Results were such that additional units, which are of an improved design developed from this experience, have been placed in service. These new two-ton locomotives, made by the General Electric Company, are strongly constructed and of clean-cut design, and possess interesting features. A single automotive motor, Type GE 1091, with one pinion, drives both axles through two sets of double-reduction spur-gears. An additional countershaft that carries the brake wheel is geared to run at the same speed as the motor, and a rigid cast-steel oil-tight housing completely incloses all the gears and shafts. The side and end frames of slab-steel, which are rigidly supported on the axles through Hyatt roller bearings, complete

Assembly drawing of unequipped midget locomotive



the solid and strong mechanical construction of the unit. This same principle of rigidly supporting the entire weight on Hyatt roller bearings was adopted on the five-ton capacity tunnel cars used at the property.

Elimination of springs, brake shoes, brake riggings, and sanders is the direct result of experience. Studebaker - type band brakes have been found to give perfect operating control. The locomotives as furnished by the General Electric Company are shown in the accompanying assembly drawing. In the photographs the units appear completely equipped with bumpers, couplings, seat, and trolleys, all of which were designed by the master mechanic of the aforementioned company.

Front view of midget electric locomotive, showing details of bumper and coupling arrangement

Bumpers and couplings are made to suit both the small mine cars, which use pin and chain couplers, and the larger tunnel cars, which are equipped with MCB couplers. The coupler not in use is swung back within the bumper.

The midget locomotive, when unequipped, has a net weight of 3,650 lb.. but with accessories it weighs 4,000 lb. It handles a load of 15 tons of ore at a round trip speed of 5 miles an hour. As the over-all dimensions of these locomotives with bumpers removed are 48 in. long by 31 in. wide by 43 in. high, it is possible to move them through sub-shafts to various sublevels. All motor-generator sets on the double trolley systems are provided with automatic relays that cut down the voltage on overload or short-circuit conditions by changing over the generator to a steep drooping characteristic. The voltage automatically rebuilds on removal of the overload or short circuit. This arrangement completely avoids any trouble that might develop by shorting of the two trolley wires.

A New Graphite Product

A NEW graphite paste has been put on the market for sealing screw thread, flange, and gasket joints of pipe lines carrying hot or cold oils, gasoline, and similar liquids. Being insoluble in oils and gasoline, this product will have many applications in oil fields and refineries as well as extensive industrial uses on creosote, tar, vegetable, and animal oil lines. It can well be used for connecting pipe lines carrying flotation oil.

Dixon's Graphite Seal, which is the commercial name of the product, expands when subjected to heat and makes leak-proof joints that hold tight under all conditions of service. Yet these joints may be opened with ease at any time without delay or damage to tools or fittings. It is also recommended as excellent for use on hand-hole and manhole plates, or wherever there is a flange and gasket connection.

The Joseph Dixon Crucible Company, of Jersey City, N. J., will be glad to send further information and samples for tests to those interested.

Use Air Mail for All Inter-office Correspondence

FOR more than a month the Stephens-Adamson Manufacturing Company of Aurora, Ill., have been using air mail exclusively for every ounce of mail between the main office and the Pacific Coast factory at Los Angeles. C. H. Adamson, secretary of the firm, reports that he can now mail a letter Monday afternoon and depend on having his reply, with required blueprints, data, and other pertinent information, on his desk Friday morning. By regular first-class mail he considered himself fortunate to receive his answer by the succeeding Tuesday or Wednesday. The experiment was started before the recent reduction in air mail rates to 5c. for the first ounce and 10c. for each additional ounce, and even at the old high rates the saving in time was well worth the added cost. Mr. Adamson says that in several instances his firm has been able to produce and ship an elevator or conveyor three or four days ahead of schedule, and traces the saving in time directly to air mail.

INDUSTRIAL NOTES

TWO new devices have recently been announced by the General Electric Company. One of these is a motor-control switch suitable for reversing small a.c. motors in installations where the motor can be thrown across the line. It consists of two triple-pole barrier-type, magnetically operated contractors, mechanically and electrically interlocked, and two hand-reset temperature-overload relays mounted on a molded base and inclosed in a drawn-shell inclosing case. By its construction the switch has a high interrupting capacity with minimum arcing. The two temperature overload relays protect the motor from overheating arising from mechanical overload or single-phase operation. The switch is expected to find application on general-purpose motors when infrequent or frequent reversing is required. Among these are motor-operated doors, valves, and machine tools.

The other device is a new signal relay intended for use where a small, inexpensive device is needed to actuate a warning signal when power fails or voltage drops on an important circuit. This device is known as No. CR-2904-F-1. In operation, the coil circuit of the relay is connected across the two legs of power supply which it is desired to watch. When the coil is thus energized, the relay contacts are held in an open position. By connecting a circuit through the contacts to some signaling device, warning will be given when the power fails or the voltage drops.

A new type of totally inclosed fan-cooled electric motor is being placed on the market by the Cleveland Electric Motor Company, Cleveland. It is designed to meet severe operating conditions. The motor is built with a double shell. The inner shell, which contains the entire motor, is completely inclosed and dustproof. It is mounted in the outer shell so as to allow a free air space between them. One end-cover of the outer shell is provided with holes for admitting air. At the end opposite the motor pulley a fan is mounted in the space between the inner and outer end covers. This draws a steady current of air into the space through the holes.

PATENTS

CORE DRILL. No. 1,677,925. July 24, 1928. J. S. Mitchell, assignor to Sullivan Machinery Company, Chicago.

FLOTATION MACHINE. No. 1,678,087. July 24, 1928. E. H. Shackelford, Jr., assignor to Hubbard Manufacturing Company, Joplin, Mo.

A flotation machine including a spitzkasten, having an elongated casing extending longitudinally along its bottom, the casing being provided with means for discharging pulp and oil. The machine is provided with means for discharging pulp and air into the entrance of the casing.

FLOTATION. No. 1,678,311. July 24, 1928. Gale L. Adams, Elizabeth, N. J., assignor to Standard Oil Development Company.

A process of concentrating ores, which comprises agitating the finely divided ore with water and a small quantity of a mixture containing 80 per cent of pressure-still tar, about 19 per cent of residuum from hydrolysis of sulphated olefines, and about 1 per cent of a water-soluble sodium sulphonate of petroleum hydro-carbons, aëration and separation of the froth.

NEWS OF THE WEEK

Summary

Germans to exploit bauxite in Greece. Page 271.

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Many Arizona mines are planning new construction. Page 272.

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Operations in British Columbia marked by unusual confidence and activity. Page 270.

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Santo Domingo mine, in Jalisco, Mexico, starts construction of a 100-ton mill. Page 272.

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High quicksilver prices exert stimulating effect on prospectors in Nevada and Oregon. Page 269.

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New electrolytic zinc-recovery plant of Sullivan Mining Company prepares for production at Kellogg, Idaho. Page 269.

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Body of American and $25,000 consignment of copper lost at Antofagasta when lighter upsets in fairway off the port. Page 272.

* * *

Real del Monte, U. S. S. R. & M. subsidiary, is exploring near Guanajuato for the extension of the "Lost" Mother Lode. Other Mexican news. Page 273.

* * *

George L. Walker summarizes the latest results at N'Changa, one of Rhodesia's promising copper prospects. More capital will be needed to develop this deposit properly. Page 271.

* * *

Granite-Bimetallic, an old Montana silver-gold producer with a record of $32,000,000, may be worked again. Flotation re-treatment of several tailing piles, as well as exploration of the workings, is planned. Page 271.

Quincy Mining May Attempt Copper Recovery From Waste Amygdaloid Sand

Tailing Deposit in Torch Lake Totaling 29,000,000 Tons Said to Contain 8 Lb. of Metal to the Ton—Recoverable by Fahrenwald Methods

W PARSONS TODD and William M. Belcher, president and vice-president, respectively, of the Quincy Mining Company, are in the Michigan copper district. The purpose of their visit has not been officially divulged, but they are looking into the recovery of copper from the company's waste amygdaloid sand or tailing by means of the flotation process developed by A. W. Fahrenwald, of the U. S. Bureau of Mines, as part of the research program instituted by Dr. W. O. Hotchkiss, president of the Michigan College of Mining and Technology at Houghton. Experts have estimated that there are 29,000,000 tons in the Quincy deposit in Torch Lake, running from 4 to 14 lb. of copper per ton, with an average content of 8 lb. Using the Fahrenwald method, 6½ lb. could be recovered, at an estimated cost of 7c. per lb. Provided all the tonnage could be reclaimed, it would yield over a term of years a total of 188,500,000 lb. of copper.

Methods of handling the tailings are being studied. It is probable the sand will be brought into the mill for treatment, using a suction dredge or similar process to reclaim the tailings from the lake. Other amygdaloid-sand deposits in the district also are amenable to reclamation.

The 87th or bottom level of No. 6 Quincy shaft continues in ground with extra good deposition of copper.

July Copper Shipments Heavy

Copper shipments by boat out of the Michigan district in July were the heaviest for a single month in many years. A total of 18,450,000 lb. was shipped. Of this amount, Calumet & Hecla moved 12,212,000 lb., and 6,238,000 lb. was loaded at the Michigan smelter, representing Copper Range, Mohawk, and Isle Royale copper. Shipments to New England and Michigan points are particularly heavy.

Mine Taxation Revised

The Michigan State Tax Commission has recommended an increase in valuation for Houghton County from $50,000,000 to $53,900,000. However, a reduction of $4,000,000 in the general state property tax is forecast by the Auditor General; and mining companies, which pay the greater part of the taxes in Houghton County, will not pay an increased tax.

Ahmeek and Allouez Push Development

In Ahmeek, rich amygdaloid producer of Calumet & Hecla Consolidated, extensive development is under way in No. 2 shaft. It is being lowered a total of five levels. Starting at the 40th, it has been sunk for two lifts and now is headed for the 43rd. Drifting and stoping are proceeding above the 37th, and from the 37th to the 40th development is in progress. In Allouez ground, which is reached through No. 2, stoping is being done in the 30th level, and drifting is proceeding in the 34th, 35th, 36th, and 37th. When these four drifts reach the boundaries, permitting retreating stoping, larger tonnages from Allouez will be possible. Ahmeek is installing two large electric pumps at the 21st level of North Ahmeek to cope with the flow of water which will come through Mohawk eventually.

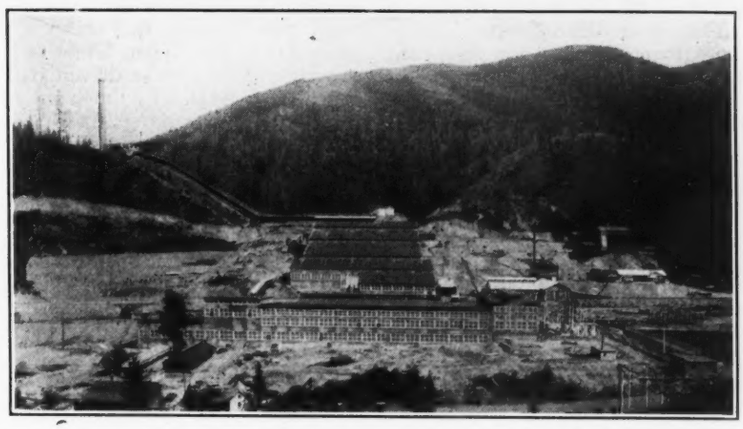
The Situation at Seneca, Mayflower-Old Colony, and Arcadian

Engineers acting for Eastern interests recently visited the Seneca mine and made a detailed examination of the property. In view of the improvement in the copper situation, some announcement relative to Seneca's future plans is expected soon.

Mayflower-Old Colony's crosscut, now 3,600 ft. from the shaft, is the longest active crosscut in any property in Michigan. No copper in commercial quantity has yet been found, but there is always the chance of a strike. Considerable territory remains to be cut, and the work will proceed. In spite of the length of the opening, no trouble with ventilation is experienced.

At Arcadian Consolidated, the drift on the east, or New Arcadian vein, at the 1,700 level of the New Baltic shaft, has been driven 45 ft.; it carries copper in commercial quantity the entire distance. Drifting both north and south will be carried on to thoroughly prove up this lode. The copper is distributed more uniformly than on the 1,250 level.

New Sullivan Zinc Plant to Start Production Soon



Two views of the new Sullivan electrolytic zinc plant at Kellogg, Idaho

LIGHTING the fires in the Wedge roasters at the Sullivan electrolytic zinc plant, at Kellogg, in the Coeur d'Alene mining district, Idaho, on Aug. 3 was the first step toward production of refined zinc, although it may be several weeks before the product is turned out. The present plant is one of three units which will ultimately be constructed. Work on the second unit will proceed immediately following the adjustment of the first and placing it in successful operation.

The capacity of the first unit is 60 tons of metallic zinc per day, and the three units will produce approximately 175 tons per day. At the Sullivan plant the process used is the Tainton, invented by U. C. Tainton, who has given his personal attention to planning and constructing the Sullivan plant. The plant was built and is owned equally by the Bunker Hill & Sullivan Mining & Concentrating Company and the Hecla Mining Company, operating through the Sullivan Mining Company.

As it stands today the plant represents an investment approaching $2,000,000. The ore supply for the first unit will come mainly from the Sidney and Douglas mines, sufficient ore being drawn from the Star mine, owned by the Sullivan company, if necessary to maintain maximum capacity. Upon completion of the second unit the Star mine will operate at full capacity, having sufficient ore blocked out to supply it.

Grandview and Z-Canyon Merger Completed

ANNOUNCEMENT has been made from the office of Grandview Mines that the long-projected merger between it and the Z-Canyon Lead & Zinc Company, both of which are operating in the Metaline district, Washington, has been completed. The Grandview company is erecting the first 500-ton unit, designed under the supervision of W. L. Ziegler, mill superintendent for the Hecla Mining Company, of Wallace, Idaho, and expects to have it in operation by the end of October. The coarse-crushing plant will have a capacity of 2,400 tons. Units will be added to the fine crushing and flotation plant as they are needed. The Z-Canyon company is reported to have demonstrated by diamond drilling that the Grandview orebody extends into its territory; hence the merger seems to be highly desirable.

High Quicksilver Price Stimulates Prospecting in Nevada and Oregon

By Paul Wooton

Washington Correspondent, Engineering and Mining Journal

REPORTS to the U. S. Bureau of Mines indicate that with the price of quicksilver approaching the maximum reached during the war, great interest is being manifested in Nevada and Oregon in quicksilver prospects. Though some of this activity is evidenced by those who would launch highly speculative enterprises, most of the interest shown is confined to responsible mining men.

In other quarters where price trends are followed, it is fully expected that Spain and Italy, now that they seem to be in full agreement, will see to it that the price is kept as high as the traffic will bear.

The chief sufferers in this country from the artificial situation which has been created are the chemical manufacturers who produce mercurial compounds and salts. There was a time when such a situation would have penalized heavily those engaged in the recovery of gold and silver by amalgamation, but with improvements in practice little mercury is now used for that purpose.

The apparent determination of Spain and Italy arbitrarily to fix a high world price has a particularly important bearing on a promising development in the generation of power — the mercury boiler. Others whose interests are affected adversely by the virtual corner of an essential commodity are the manufacturers of electrical equipment and of scientific instruments.

Increased interest is manifested, also, in tungsten properties. Evidently this has its origin in the chance that an increase in the import duty may grow out of the investigation which the U. S. Tariff Commission now is conducting.

Montana Club Co-operates with Federal Survey in Geological Research

Under a co-operative agreement with the Helena Commercial Club, the U. S. Geological Survey is making studies of the geology in that region of Montana of which Helena is the center. The work is being conducted by J. T. Pardee and Frank Schrader. The Commercial Club advanced $2,500 toward the work. The Survey will contribute approximately $5,000.

Owing to the fact that Montana has no state geological survey, the amount of general geological knowledge as to mineral deposits in that state is relatively small. Because of the lack of a co-ordinating agency, the amount of work done in the state by the U. S. Geological Survey has been small. The hope is expressed that this year's geological studies may constitute a stepping stone toward the establishment of a department in the state that will be in a position to co-operate with the federal Survey.

British Columbia Operators Confident and Busy

Discoveries and Development Mark Record for First Half of 1928— Many Properties Drilling

THE past month has been active in mining in British Columbia. At New Hazelton the Silver Cup Mine is getting started on the installation of its new mill, which will mean much for the economic development of this mine on a larger scale than heretofore. Usk section is having several properties opened up. Lack of capital for development has long held back this very promising region.

At Pacific the Consolidated Mining & Smelting Company has two properties and has men at work there, with R. G. Watson in charge. George H. Kilburn and D. C. McKechnie, field engineers for the company, spent some days looking over that section in July.

C. M. & S. Leases Atlin Silver Lead

Consolidated Mining & Smelting of Canada evidently is planning a heavy season of development. Besides continuing the development of most of the properties it started to explore last season, it has taken a lease and option on the Atlin Silver Lead Mining Company's property, on Fourth-of-July Creek, near Atlin, in the extreme northwestern part of the province; the Duchess and Contention groups, on the south fork of the Telkwa River, about 30 miles from Telkwa station, on the Canadian National Railway; and the Harvey group, in the Babine Range, and it has started work at all properties.

The Atlin Silver Lead property contains several parallel veins, on some of which a considerable amount of development has been done. Federal Mining & Smelting had an option on a controlling interest in the company, and did a large amount of exploration before allowing its option to drop in 1926. The veins range from a foot up to 20 ft. in width, and some well-defined shoots of silver-lead ore have been developed; the ore usually contains gold also. Several small shipments of high-grade ore have been made. The veins are much broken and oxidized near the surface. New York interests did a considerable amount of exploration on the Duchess group some 20 years ago, and exposed an 18-ft. lode, 11 ft. of which is said to be milling-grade copper ore under present market prices.

Engineer Gold Mines Resumes

Engineer Gold Mines, which suspended mining operations during the winter, has resumed work at its property, near Atlin. Development at this property up to now has been disappointing, especially in the face of the exceedingly optimistic reports, which caused the shares to jump to more than twenty times their par value on the New York Curb. During last year the company treated 4,189 tons of ore and recovered 2,025 ounces of gold and 1,400 ounces of silver.

Granby Profits Go Up

The Granby Consolidated Mining, Smelting & Power Company reports an operating profit of $746,609 for the second quarter of this year, which compares with a profit of $513,591 for the corresponding quarter of last year and one of $553,601 for the first quarter of this year. Profits in all instances are before depletion and depreciation.

Other Groups Active

At Duthie mine, near Smithers, shipment of concentrates continues undiminished, and it is now reported that in diamond-drill operations a further new discovery of high-grade ore has been made at a depth of 100 ft. below any of the present workings.

Angus Chisholm, an old-time prospector, made a new discovery of high-grade galena running $150 to $200 per ton across 3 ft., about a month or so ago. This is on Hudson Bay Mountain, on a bare mountain top above the Schufer mine. Chisholm and others have already opened it up at several points over a length of a thousand feet and have one shaft down to a depth of 12 ft. in solid ore.

In the Babine Range, the Consolidated Mining & Smelting Company has taken up the Harvey group and other surrounding claims, and it is said will be ready to proceed with development by way of diamond drilling soon as the Driftwood Creek road to the Babines has been made passable. This road required a lot of repairs and promise was made to extend it four miles.

The Alexandria Gold Mines, Ltd., has taken over the option of E. G. Brown on the Hyland Basin property, in the Babine Range, and had an engineer, Mr. Davy, inspect it during July, and then R. W. Haggen, of Vancouver, arranged to make a survey of the claims. Grant Mahood, of Toronto, one of the principals in the company, recently inspected the property.

In addition to its developments on the Duchess and other properties on the Telkwa River, the Consolidated Mining & Smelting Company has D. C. McKechnie, field engineer, looking over many of the properties in the district.

Jessie group, on Hudson Bay Mountain, has opened up extremely well under development being carried on this summer. Surface work now shows good ore continuous in length for 1,600 ft. in a number of veins. A recent find in another part of the No. 2 vein, not hitherto opened up, is reported to show good ore across a width of 2 to 3 ft., and this has been opened up now for a length of more than 50 ft.

Topley Richfield diamond drill operations are reported to be meeting with success. On the east vein, a new 400-ft. discovery of this spring, four holes sunk to a depth of 400 ft. each are said to be in high-grade ore all the way down, and another diamond drill on the west vein is now down over 900 ft., and the best ore is said to be that at the greatest depth.

Winder Stillman Copper Shipping Steadily

Modern Mill and Power Equipment Responsible for Recovery of 90 to 95 per Cent

MINING and milling operations at the property of the Winder Stillman Copper Company, situated 9 miles southeast of Salmon, Idaho, have recently been highly satisfactory, according to J. Benjamin Parker, manager and metallurgist of the company. Shipments are being made steadily,

Current operations began the latter part of last year, when the Pope-Shenon Mining Company, which formerly controlled the property, was reorganized to form the Winder Stillman company. Since that time development work has progressed rapidly, and the mill has been remodeled and increased to 100-ton capacity. No. 6 tunnel is now in a distance of 800 ft., and the vertical downward extension of the orebody mined formerly in the upper levels has been encountered in a raise driven from No. 6 to No. 5 level. In the hanging-wall side of the old workings on No. 5 level, ore 5 ft. wide, and ranging from 11 to 17 per cent in copper content, has been discovered; and in another stope on the same level 6 per cent copper ore is being mined over a width of 22 ft.

Actual extraction operations at the property, which comprises 150 acres, began on July 1, when the remodeled mill was completed and placed in operation. Mill heads have averaged 6 per cent, the copper being present in the form of malachite, azurite, chalcopyrite, and chalcocite; some gold and silver is also present. Recovery ranges from 90 to 95 per cent.

Equipment in the mill includes a 10x12-in. Universal crusher, 5x5-ft. Denver Engineering ball mill, Dorr simplex classifier, three 8-ft. Parker flotation machines, and one two-leaf 6-ft. American filter. Electric power supplied by the Idaho Power Company is used. A 10x12-in. Ingersoll-Rand compressor of 160 cu.ft. capacity is employed in operating the six rock drills in use. A crew of 35 men is maintained.

Officers and directors of the company, all of whom reside in Salt Lake City, are: R. H. Winder, president; J. W. Jones, secretary-treasurer; S. Stillman, E. J. Kearns, and J. A. Kearns.

Premature Blast Kills Two

John E. Griffiths, president and general manager of the Gold Medal Mining Company, in company with William Haus, an employee, was placing dynamite in the tunnel of the Gold Medal, Idaho Springs, Colo., on Aug. 8 for the final blast of the day. A premature explosion killed both men instantly. Mr. Griffiths came to Colorado from Pittsburgh. Haus came from Mount Sterling, Ill. The cause of the explosion will probably never be known, as no one was present except the two men now dead.

Dambo Lode, in Rhodesian Copper Belt, Grows in Importance

Diamond Drilling at N'Changa Copper Indicates Large Deposit of 4 Per Cent Copper—More Capital Will Be Needed to Develop and Equip Subsidiary of Rhodesian Congo Border

By George L. Walker
Special London Correspondent

RESULTS of diamond drilling, underground development, and further geological investigation of the ore deposit in the property of N'Changa Copper Mines, Ltd., near Tshinsenda, in Northern Rhodesia, immediately south of the Katanga region, continue extremely interesting. The company was formed in 1926 by Rhodesian Congo Border Concession to develop an area, 3 miles in length and 1½ miles in width, along the Dambo lode. The property gives promise of a large tonnage of ore ranging from 3½ to 4½ per cent in grade, and at one end it has shown signs of increasing in extent and richness, so that the possibility of another large mine beyond the N'Changa boundary is indicated.

Recently, two new holes were started, following the disclosure of 130 ft. of 4.56 per cent copper at a point several hundred feet north of the so-called "New Discovery," situated in the southwest corner of the N'Changa quadrangle.

No official estimates of probable tonnage to be developed are being made, but it is declared that "the amount will be large is already assured." According to the geological map, the prospective ore area is about 9,000 ft. long and has an average breadth of about 4,500 ft. The indicated tonnage, assuming an average width of 80 ft. is more than 200,000,000, and the copper content would be enormous on the basis of present samples and assays.

An interesting feature of this deposit is that it shows no indication at any point of those alternating belts or shoots of relative richness or poverty such as characterize most orebodies in other parts of the world. Except in the leached zone, there seems to be astonishingly little variation in grade.

The N'Changa deposit was found in 1923 by a prospector employed by Rhodesian Congo Border Concession. He noticed some rather unimpressive copper stains in small outcrops close to what is now known as the River Lode. Several months afterward two of the company's engineers attempted, when in that vicinity, to find it. Failing to discover it, they returned later, accompanied by the prospector, who pointed it out to them. There were no workings, ancient or modern, it being different in this respect from the Bwana, the Roan Antelope, and the N'Kana, all of which had been worked.

Exploration of the River Lode revealed good values from the start. In 1925 indications of mineralization were found about 4,000 ft. south, consisting of copper stains in the soil, and this became the Dambo Lode. After enough work had been done to develop the possibility of the existence of a syncline, Rhodesian Congo Border formed the N'Changa Copper Mines, Ltd., to which it sold the property for 225,000 shares of N'Changa and £65,000, Rhodesian Congo Border shareholders taking 300,000 shares at £1 each.

As N'Changa has had only about £210,000 for equipment, development, and other purposes, it will soon need more money. The work will be carried on while financing plans are considered, the directors having arranged for temporary advances. No. 9 shaft, on the River Lode, has now reached a depth of 322 ft. A crosscut on the 300 level has entered ore for a distance of 50 ft. Results of preliminary sampling show that more than 80 per cent of the copper at this depth is in sulphide minerals.

Processes of ore treatment are being tested. Minerals Separation, Ltd., which owns a block of N'Changa stock, had several tons of ore sent to London. More than three tons has been submitted, in 150 lb. lots, to tests by the copper segregation process, each with reported success. This process consists of cement-kiln furnacing of the ore at low temperatures in the presence of certain reagents, followed by flotation. It is declared that such treatment "yields high-grade concentrates, with excellent recoveries."

Germans Will Exploit Bauxite in Greece

AN AGREEMENT has been signed between a group of German aluminum producers, including the Vereinigte Aluminum Werke in Lautawerk, Lausitz, Germany, and Ota wi Minen und Eisenbahn Gesellschaft, of Berlin, and the Barlos Greek Bauxite Mines Company, which holds valuable concessions in Greece. The agreement provides for the creation of a new company, in which each of the three existing companies will hold an equal interest, for the exploitation of four of the seventeen concessions of bauxite fields owned by Barlos Greek Bauxite at Distomon, Beotia, Bay of Corinth, Greece.

Granite-Bimetallic Plans To Develop Peer Claim

RESUMPTION of company operations by the Granite-Bimetallic Consolidated Mining Company at the property of the company at Philipsburg, Mont., are under consideration by the management. Plans include exploration and development on the eastern extension of the main vein into the Peer claim, and flotation re-treatment of several tailing piles that contain about 200,000 tons. The property, which comprises 2,500 acres, has been operated intermittently by leasers since 1906.

Holdings of the company consist of the former interests of the Granite Mountain and Bimetallic companies, which were merged in 1898 to form the present controlling organization. Both properties were large producers of silver and gold, their total output being valued at more than $32,000,000. From 1898 to 1904 about $1,000,000 a year was obtained from the ore, but in August, 1905, the entire property was shut down, as a result of the decline in the price of silver and the low grade of the ore that was then being mined. Later a portion of the property was reopened under a leasing system of operation.

Underground workings include over 20 miles of drifts and crosscuts, five drift tunnels, a drainage adit, and two shafts —the Granite, or Ruby, shaft, 1,550 ft. deep, and the Bimetallic, or Blaine, shaft, 1,800 ft. deep. Stoping on the vein has extended to a depth of 2,600 ft. below the surface. A gravity concentrator, a crusher building, and hoist houses are on the property.

Surface plant at the property of Granite-Bimetallic Consolidated Mining Company at Philipsburg, Mont.

Santo Domingo Will Operate 100-Ton Mill

Cinco Minas Deposits Nearly Exhausted—Los Moros Strikes New Copper Ore—Other News from Jalisco

THE SANTO DOMINGO mine, owned by the Compañia Española, in the Hostotipauillo district, State of Jalisco, Mexico, has recently started construction of a 100-ton mill, which it is hoped will be in operation by the end of the year. The property is situated 5 miles from the famous Cinco Mines property, on the banks of the Santiago River. Reports from the district state that the Cinco Minas mine is being cleaned up and that it probably has not more than two years to run. This company has paid more than $4,000,000 in dividends, on an initial capital of $500,000, since the start of operations. It has mined the gold-silver ore of the district practically without interruption through the various revolutions since 1910. Operations are conducted electrically, including a 500-ton concentration and cyanidation plant. H. E. Crawford is the general manager.

Los Moros, a property of Magistral Ameca Copper, situated about 8 miles from Ameca, Jalisco, is employing 100 men in exploration and development work. It is reported that a large body of 2½ per cent copper has been developed at the mine. Operations are now in charge of Charles Hoyle, for many years in charge of the Esperanza mine, at El Oro. The Magistral mine is giving employment to about 200 men. A crosscut to the orebody is being driven to the 500 level. Output is being restricted at present, pending the installation of the electrical plant from Chapala. This will probably be effected by the first of November. The Magistral is owned principally in Pittsburgh and Boston, with main offices in the latter city. A 125-ton concentrator, with flotation units, treats the ore from both mines.

Recent discoveries of new orebodies at the Amparo and Mazeta mines, near Ezatlan, Jalisco, give assurance that this camp will continue to produce for several years. The situation some months ago was rather discouraging. Both properties are owned by Amparo Mining, of Philadelphia.

Many Arizona Mines Plan New Construction

THE Christmas Copper Company, operating at Christmas, Ariz., of which F. A. Woodward is general manager, is completing its plans for the construction of a concentrating plant of 500 tons' daily capacity. At present production is limited to 100 tons per day, which is the requirement of the Hayden Smelter for the type of ore produced.

Collins Western Corporation has the contract to erect a mill at the Spring Creek Mine, at Young, Ariz.

The Mule Mountain Copper Company of Bisbee, Ariz., has been issued a certificate of incorporation. It is capitalized for $1,000,000 and incorporated by Robert Coughran and George Kelsey, of Bisbee.

The Arizona Cinnabar Company; the Tonto Mining Company; and the Mines Mercury Company of America, operating near Globe, Ariz., have consolidated, and will erect a 200-ton smelter on the property. All the mercury produced will be shipped to New York.

The Slag Paving Brick & Products Company, Globe, Ariz., has been organized with a capitalization of $750,000, and is starting construction work on the erection of a plant at an estimated cost of $250,000. The company has contracted for the large slag deposit of the Old Dominion smelter, and will manufacture slag brick, sewer and drain pipe, tile and other similar products.

Arizona Magma Mining Company, Chloride, Ariz., of which T. H. Crabtree, is superintendent, has shipped a carload of ore from its Diana mine. The drift on the 300 level has been driven 130 ft., with no change in the character of the ore. The shaft on the George Washington Extension is now being sunk below the 100 level, and has passed through a 2-ft. vein of native silver ore. C. T. Carpenter, president of the company, is in New York conferring with the board of directors as to mill construction plans.

Loading copper at Antofagasta

Copper Consignment and Body of Collins Lost at Antofagasta

Copper bars valued at $25,000 were lost on Aug. 11 when a barge, which was hauling them to the steamship "Essequibo" for shipment, overturned in the Pacific, at Antofagasta, Chile, according to a cable dispatch to the New York *Herald Tribune*. The coffin containing the body of the American named Collins, who was killed in the recent explosion at the du Pont powder works at Calama, was also thrown overboard. The method of loading copper at Antofagasta is shown in the accompanying illustration, which is reproduced from the front cover of *Engineering and Mining Journal* of Sept. 10, 1927.

Two Old California Mines to Be Reopened

THE Sliger mine, near Greenwood, El Dorado County, Calif., has been reopened, and twelve men are employed. The property is an old one that was equipped in 1923. The company is the Sliger Gold Mining Company, of which W. R. Simpers is president; H. W. Simpers, secretary-treasurer; and C. A. Danielson, manager.

Permits to sell the securities of the Blue Bell Gold Mining Company and the Nevada Tungsten Company were recently revoked by the California State Corporation Department. Permit to sell 25,000 shares at $1 per share in California was issued to the American Gold Dyke Mining Company, of Reno, Nev.

Eagle Bird's property, near Washington, Nevada County, will be reopened.

Parnall Gold Mining Company, of Los Angeles, has purchased mining claims in the Nevada City area.

The Cleveland mining property, in the Bully Choop district in Trinity County, west of Redding, Calif., has been reported purchased by the Florence Goldfield Mining Company, of Goldfield, Nev.

Gas fumes resulting from the exhaust of a gasoline engine caused the death of two miners in a prospect east of Victorville, Calif. I. S. Emerson and H. Zafftke were the victims.

London Letter

By W. A. Doman
Special Correspondent

Sir Robert Horne Declares Lead and Zinc Mines Are Overproducing

London, July 31, 1928—With the annual meeting of the Zinc Corporation, the last of the big English mining companies has met its stockholders, for a time at least. Sir Robert Horne, in presiding at this meeting, gave an interesting review of the metal market. He said that there was ample evidence that the consumers of the world cannot yet comfortably absorb production of the volume of 1926 and 1927, and there is abundant proof that the world's resources of lead and zinc cannot suffer for any great length of time the enormous drain that is being annually made upon them by producers. This appears to him to be a very good time for considering better regulation of market supplies, and, if need be, regulation of production. He does not believe in high prices, and extremely low ones are equally bad. "I believe in stability of prices at fair levels, and I earnestly commend to the world's industry the view that those chiefly interested—and they are by no means many—should now consider whether it may be possible to reach such a result."

OWING to the fall in metal prices, the Zinc Corporation last year restricted development. Nevertheless, there was an increase in ore reserves of 159,646 tons, raising the aggregate to 2,626,707 tons containing 14.6 per cent lead, 3.1 oz. silver, and 10.7 per cent zinc. The zinc reserves are 245,696 tons containing 6.4 per cent lead, 1.4 oz. silver, and 18.1 per cent zinc. Results from the concentrating plant are high, the recoveries of metals being 92.7 per cent lead, 87 per cent silver, and 80.3 per cent zinc. In 1909 the recoveries were 75.1 per cent lead and 60.5 per cent silver. In conjunction with the North and South Broken Hill companies, the Zinc Corporation is considering the creation of a great central power unit.

National Smelting earned smaller profits in 1927 than in 1926, the total being £176,092, against £330,752. A conservative dividend policy having been pursued, the same rate of dividend on the ordinary shares—10 per cent—is being paid.

I understand that Mr. Bridgman, the representative of Guggenheim's, of New York, was in London a fortnight ago and signed a contract for the lease of the Aramayo Mines, in Bolivia, for a period of ten years.

Mond Nickel £1 shares have been divided into 10s. denomination, and the capital has been increased from £4,900,000 to £5,500,000.

A report current that the Banque de Paris et des Pays-Bas was at the head of a group to advance a loan to the Russian Soviet on the security of platinum is denied as without foundation.

Partly to finance the new works of Penpoll Tin Smelting, whose entire capital is held by the London Tin Syndicate, the latter is issuing 100,000 of its 200,000 unissued shares at the price of £3 5s. per share in the proportion of one new for four held.

Mexico City Letter

By W. L. Vail
Special Correspondent

Real del Monte Will Drill for "Lost" Mother Lode in Guanajuato

Mexico City, Mexico, Aug. 3, 1928.—Real del Monte y Pachuca, a subsidiary of U. S. Smelting, Refining & Mining, has taken an option on territory in the Guanajuato district of Mexico, where attempts have recently been made to discover the "lost" Mother Lode. It is reported that the new lessees propose to sink several holes by diamond drill and possibly a shaft for the purpose of further testing the value of the ores. The strike of what is said to be the extension of the Mother Lode was made last winter on the properties of the Peñoles company at a depth of 1,180 ft. There appears to be no doubt on the part of local mine operators that the lode has been struck, the question in their minds being one of grade. Three geologists from the Real del Monte mine at Pachuca have completed an exhaustive study of the grounds.

EL ARCO Mining, situated in the Panuco district of Sinaloa, is reported to have struck bonanza ore, on the strength of which additional machinery is being installed. To facilitate the work, a new road has been constructed to the mine from a point known as La Piedra Lisa. El Arco is owned and operated by American capital.

Operations have been resumed by Amatlan Mining at its silver-lead properties in the Chalchihuites district of Zacatecas. J. H. Caranahan is manager of the property, which is equipped with a small concentrating plant. Work was suspended some time ago because of political conditions. The stock of the company is owned principally in Tampico.

Officials of Amarillo-Panhandle Under Arrest

On Aug. 2 seven officials of the Amarillo-Panhandle Development Corporation were arrested at the offices of the company in the Midland Savings Building, at Denver. According to report, charges of fraud are to be preferred. The trial will be held at La Junta, Colo., the county seat of Otero County.

Melbourne Letter

By Peter G. Tait
Special Correspondent

Japan May Use the Iron Ores From Yampi Sound Deposit, in Western Australia

Melbourne, July 13, 1928.—The iron deposits of Yampi Sound and Cockatoo Island, in the northwest of Western Australia, are again before the public. It will be remembered that the Queensland government, which proposed to establish iron and steel works, acquired several leases a few years ago so as to insure a supply of raw material. However, the project did not materialize, and recently the leases were sold to the Hoskins Iron & Steel Company, now known as Australian Iron & Steel, which has established new works at Port Kembla, New South Wales. Up to the present, however, no arrangements have been made for shipments of ore from Western Australia.

K. Osada, of the mining department of the Japanese government, in company with representatives of Asano & Company, of Tokio, recently visited the district to inspect the deposits with a view to arranging for shipment of ore to Japan. No official announcement of the result has been made.

THE low prices of lead and zinc preclude the working of many of the smaller mines at Broken Hill, with the exception of those containing high-grade ore. The Junction mine, which was recently acquired by the Sulphide Corporation from the old Junction North Broken Hill mine, has been closed down since last September, and the manager recently asked for a further period of exemption from the labor covenants on the ground that profitable work was impossible at present market rates for metals. He said that £24,000 had been spent in equipment for the improvement of working conditions. The total expenditure for the years from 1924 to 1927 was £314,493, of which £279,834 was on account of mining and the remainder for development. Wages and salaries amounted to £220,000. The company guaranteed to keep the mine unwatered and ready to resume operations when a favorable opportunity occurred.

Old Moon-Anchor Mine Optioned

J. A. F. Durocher-Stone, president of the Colorado Mining Trust and other concerns, who has a lease on the Midget mine, at Cripple Creek, has taken an option on the Moon-Anchor mine, which adjoins the Midget and other properties which Stone controls in that territory. The Moon-Anchor is credited with having produced three million dollars.

BOOK REVIEWS

NEMA HANDBOOK OF APPARATUS STANDARDS, seventeenth edition, 1928. Published by the National Electrical Manufacturers' Association, 420 Lexington Ave., New York City. Pages, 348.

BEST performance and manufacturing standards of electrical apparatus have just been published as the "NEMA Handbook of Apparatus Standards," formerly known as the "Electric Power Club Handbook of Apparatus Standards." The book embraces standards of electric power, control, and measuring apparatus for the generation, distribution and utilization of electric energy. Each section, covering such apparatus as motors and generators, industrial control, transformers, switchgear, measuring instruments, electric welding and other equipment, is complete in itself, all the rules relating to each product being grouped together. Standard definitions, abbreviations, and symbols are also included for each class of apparatus.

Under the heading of "Application and Selection of Rotating Apparatus," the proper service factors are given. These are multipliers to be applied to the horsepower ratings of standard motors for use in special applications or under special service conditions, which are also defined. Full information is given regarding the effects of variation of voltage and frequency upon the performance of induction motors.

American standard connections and terminal markings of motors, generators, converters, and transformers are given in full. The section on "Industrial Control" includes the rules approved as "American standard," by the American Engineering Standards Committee, with additional standards and recommendations adopted by NEMA and not yet presented to the committee for adoption.

EXCAVATING MACHINERY, as Represented by Power Shovels, Drag Lines and Grabbing Cranes. By W. Barnes. Published by Ernest Benn, Ltd., Bouverie House, 154 Fleet St., London, E. C. 4, England. Pages 247. Price 42s.

COMPANIES operating excavating machinery of the type indicated will find this book of considerable practical value. One hundred and sixty illustrations supplement the abundant detail of the text. After setting forth the fundamental principles embodied in the design of power shovels, drag lines, and grabbing cranes, the author outlines the history of the development of these machines. He then proceeds to describe the various types, and devotes considerable attention to constructional details. Application to all classes of excavation work is then discussed. Of especial value are the two chapters entitled "Hints for the Prospective Purchaser" and "Hints for the User." The volume concludes with a chapter on auxiliary plant and its application, together with various miscellaneous information. Although written from the British point of view, the book devotes considerable attention to the equipment turned out by the prominent manufacturers in the United States.

MACRAE'S BLUE BOOK AND HENDRICKS' COMMERCIAL REGISTER, 1928 Edition. Published by MacRae's Blue Book Company, 18 East Huron St., Chicago. Price $10.

CONSTANT REFERENCE is made to this valuable book in this office. It supplies the easiest means for finding the address of a concern when only the name is known; also to find the names of manufacturers of any particular product; and to find the name of the manufacturer of a trade-named article when only the trade name is known. It is surprising how frequently information of this sort is wanted. The book is divided into three sections. Section 1, 266 pages, is known as the "Address and Local Distributors' Section." The second section, which with its 2256 pages constitutes the bulk of the book, is known as the "Classified Materials" section. This is self-indexing. The third section is devoted to trade names and contains 232 pages. Purchasing agents in particular will find the book of considerable value.

SUGGESTIONS FOR THE PRACTICE OF COMMERCIAL ARBITRATION IN THE UNITED STATES, prepared by the American Arbitration Association, and published by the Oxford University Press. Cloth, 9 x 6 in., 247 pages. Price $1.75.

This volume is a more comprehensive treatment of "Suggestions for the Guidance of Arbitration," previously issued by the Arbitration Association and intended for the use of the members of its National Panel of Arbitrators. It contains a complete description of the operation of this method of settling disputes, and points out pitfalls to be avoided. Included in the volume is an appendix that contains a compilation and summary of the New York State and federal laws relating to arbitration. It is a book that should be of interest to both executive and lawyer.

THE COST OF LIVING IN THE UNITED STATES. New York: National Industrial Conference Board. Cloth, 9x6 in., 142 pages. Price $2.50.

This book is the latest issue of a series of publications in which the results of the Conference Board's inquiries into the cost of living are set forth. The report summarizes the results of the investigations of the board since 1914, with particular attention paid to the monthly changes in the cost of living from November, 1925, to January, 1928. It contains a description of the methods employed in measuring the changes in the cost of living and a presentation of the results.

SCIENCE, ENGINEERING, AND INDUSTRY—An address by Frank H. Probert, dean of the college of mining, University of California, delivered before the Engineering Council of Utah, Jan. 28, 1928. This address has just been published in pamphlet form by the department of mining and metallurgical research of the Utah Engineering Experiment Station, University of Utah, Salt Lake City. Copies may be had free on application to the University of Utah.

ZEOLITES—D. F. Hewett, Earl V. Shannon and Forest A. Gonyer are authors of a twenty-page paper entitled "Zeolites from Ritter Hot Spring, Grant County, Oregon." Aside from the intrinsic merits of this paper, it is interesting to note that the minerals described in it were collected in June, 1915. Science, as well as art, is long, and insufficient appropriations cause further delay. The paper is No. 2737 from the Proceedings of the U. S. National Museum.

ARIZONA MINING—A general review of the ore occurrences, mines, and reduction plants in Arizona is given in Bulletin No. 125, just issued by the Arizona Bureau of Mines. The bulletin, which is entitled "The Mineral Industries of Arizona," is written by J. B. Tenney, assistant geologist of the bureau. The data contained with reference to smelters and mills were in large part obtained and arranged by Dr. E. P. Mathewson. The bulletin contains 135 pages.

MINING—G. A. Robertson is the author of a short article entitled "Eliminating Waste Rock Underground" which appears in the *South African Mining and Engineering Journal* for June 16. He outlines a method of sorting in the ore passes of a mine, so that the coarse ore and waste will move by gravity along their respective chutes. If the stopes be too flat to permit movement by gravity, he suggests that a system of shaking conveyors be employed.

RADIUM, CARNOTITE—H. A. Doerner, associate chemist at the Reno Station of the U. S. Bureau of Mines, presents notes on the extraction and recovery of radium, vanadium, and uranium from carnotite ores in Serial No. 2873 of the Bureau of Mines. In conclusion, he gives the outline of the original Bureau of Mines nitric-acid method of treatment.

OHIO GEOLOGY — J. A. Bownocker, state geologist of Ohio, announces that the Ohio state survey has issued Bulletin 33, including a map of Ohio which shows the mineral industries in the state and a directory of producing companies. The authors are Mr. Bownocker and W. Stout. The directory is sold at 25c. and the map at 75c.

Personal Notes

RUDOLF GAHL, consulting metallurgist, 1155 Laurel St., Berkeley, Calif., has resumed professional practice.

JAY A. CARPENTER, professor of mining at the Mackay School of Mines, Reno, Nev., is in San Francisco on a business trip.

W. J. SHARWOOD, metallurgical chemist of the Homestake Mining Company, Lead, S. D., is in Berkeley, Calif., on a short visit to relatives.

JAMES A. STADER, assistant to the president of the American Zinc Institute, is making a trip through the West in the interests of the Institute.

C. V. AVERILL, district engineer, California Division of Mines and Mining, is making a survey of the mineral resources of Plumas County, Calif.

G. H. SHORT, mining engineer, of Salt Lake City, has returned to his headquarters there from a business trip of five weeks to Chicago and Cleveland.

R. S. BAVERSTOCK, of the firm of Baverstock & Paine, recently returned to headquarters at Los Angeles after an examination of mines in the Alma district, Colorado.

JULIAN BOYD has been appointed consulting mining engineer of the Pacific Coast Borax Company and is also engaged in private practice at the Central Building, Los Angeles.

H. L. BERKEY, of Tucson, Ariz., is in New York for two weeks or so in connection with the development of copper and molybdenum properties in the Patagonia district of Arizona.

WALTER W. WISHON, mining engineer, of Los Angeles, is in New York at present on business. He represents the Southern Metals Corporation and the Wishon Exploration Company.

FREDERICK G. CLAPP has completed his engagement as petroleum engineer to the Imperial Government of Persia. He will continue his consulting practice and can be addressed as usual at 50 Church St., New York City.

GEORGE KINGDON, general manager of the United Verde Extension Mining Company, accompanied by Mrs. Kingdon, sailed for the Orient on the "President Taft," on July 30. He will be absent from the country about two and a half months.

M. W. VON BERNEWITZ, mining and metallurgical engineer, of Pittsburgh, is spending a short vacation in the vicinity of New York. He is devoting a part of his time to an unofficial examination of the ventilation system of the Holland tunnels between New York and New Jersey.

V. J. HAMPTON, assistant mine superintendent, Patiño Mines, Llallagua, Bolivia, who has been visiting in this country since June 25, and studying operations in Canada, the Salt Lake Valley, Butte district, and the Coeur d'Alenes, will sail from New York on Aug. 30 to return to Bolivia.

THEODORE PILGER, mining engineer, of Butte, Mont., has recently resigned from the U. S. Department of Commerce. During the last four years he has held the position of American Trade Commissioner at Berlin, Germany. He is now with the foreign bond buying department of the National City Company, 52 Wall St., New York.

JAMES M. HILL, engineer in charge of the San Francisco office of the Division of Mineral Resources and Statistics of the U. S. Bureau of Mines, has resigned to take effect Aug. 15, 1928. Mr. Hill succeeded to the San Francisco office on the retirement of the late Charles G. Yale. He will engage in professional practice and will continue "Interpretative Facts," a form of reporting which he has developed.

GUS SCOGLAND

OBITUARY

FRANCIS R. FORAKER, a director of the Kennecott Corporation, died on Aug. 10, at Santa Fe, N. M.

ALFRED BUNDY COLWELL, well-known Western mining engineer, died at Prescott, Ariz., on Aug. 5, following an operation for appendicitis. Mr. Colwell had been associated with mining ventures in Arizona, California, and Nevada, and had but a few months ago been appointed manager of the Chase Mines, in the Senator mining district, near Prescott. He was well known in the mining camp of Jerome, where he had an office for several years. Mr. Colwell was a graduate of the Michigan College of Mines.

ADAM OTTO SCHMITT, a well-known mining man in the Mercur district of Utah back in the 'eighties, died at a Salt Lake City hospital on Aug. 2. Mr. Schmitt was 78 years old. He was born at Stanternheim, Prussia, Germany, on Oct. 12, 1849, and came to this country in 1871. After residing at Independence, Iowa, for several years, he went to Utah in 1893, and subsequently was employed by the De Lamar Mercur Mines, then active in the Mercur district. Mr. Schmitt was a member of the Masonic order, and was survived by a brother in Germany.

Gus Scogland—An Appreciation

IN the death of Gus Scogland, at Oaxaca, recently from blood poisoning, the mining world loses one of its soundest hard rock miners, and I a faithful employee and friend of 22 years' association. Coming to America from Sweden when he was about twenty years old, Gus went into the Northwest and Alaska, worked at the placers for some time, and then, coming to Rossland, he worked with R. R. Leslie and Joseph F. Thorn, making a great reputation as mine foreman. The hardest man to find is a mine foreman who can be depended on to fill the bill. Once you have such a man the superintendent can be second rate, the mill man fair, the accountant just competent enough, but the overflowing mill bin always kept full of good ore is the key to the whole enterprise. Gus Scogland was that man at every property he worked. Gus was a big, husky Swede, energetic, a strict disciplinarian, a hard worker—would tackle any piece of dangerous underground work and carry it through with a rush. He knew how to handle men of all nationalities, and they all respected his ability and justice. He was foreman at Minas Prietas under George Schroter, and later under Frank M. Perry for ten years. Later he went to Salvador, where he remained to become manager of the Butters Salvador Mines, which were developed and managed by Mr. D. J. Pullinger, of Montreal, and myself, and still later manager for George Farish, of the El Salvador Silver Mines. After that he was manager for the Grecia Mines, in Nicaragua, owned by Butters Salvador Mines, and for the last three years he was developing lead-silver mines in Oaxaca for Henry Catlin, of the Electric Bond & Share Company, of New York.

Gus was a really great character, a man getting his education in hard knocks, holding the respect of every one in every job he had, his opinion sought and eagerly listened to by leading mining men. We had in Scogland a strong mentality with the nerve and ability to fight any condition and beat it. A host of friends in Alaska, British Columbia, the United States, Mexico and Central America will mourn his passing as the typical mine boss that everyone is looking for: the hardest job on the mine. CHARLES BUTTERS.

MARKET AND FINANCIAL NEWS

Trends in the European Metal Market Situation

By Dr. James Rubinfeld
Special Berlin Correspondent

FOR the first time in several months some slackening is noticed in the business of German metal concerns, though apparently it is only temporary. Mansfeld Copper Company, with plants at Eisleben and elsewhere, has been forced to diminish its working force. The refinery of Tempelhof A. Meyer, near Berlin, which controls processes for making tin from babbitt and which also manufactures electrolytic tin, as well as producing lead and copper sulphate, is being reorganized for financial reasons. Brandeis, Goldschmidt & Company, the London metal-trading firm, is an important stockholder in this organization, and it is believed that the Meyer concern will be given a chance to produce tin on a larger scale again later on. It may be recalled that Brandeis, Goldschmidt & Company, with Williams Harvey & Company, already have control over the tin refinery of Wilhelmsburg, near Hamburg, and over the metal-trading concern of Levy-Stern & Company, of Berlin, so that tin smelting in Germany may soon become controlled entirely by foreign interests that can cheaply deliver the ores, especially those from Bolivia, at the smelters.

The amount of tin ore imported into Germany in January-June, 1928, was 5,797 metric tons, against 3,932 metric tons in the same period last year. Virtually all of the 1928 imports—5,680 metric tons to be exact—came from Bolivia. It may be remarked in passing that German imports of metals and ores, so far this year, are at a rate far in excess of that for any preceding year. Imports of copper ores amounted to 158,211 metric tons, against 108,627 metric tons in the same period last year. Imports of zinc, antimony, and nickel ores and concentrates have shown correspondingly large, or larger, increases. Certainty is felt that the rate of consumption of metals in Germany this year will be even higher than the not unsatisfactory year of 1927.

Lead imports in the first half-year have been 77,800 tons for 1928, against 66,100 tons for 1927. Zinc imports are 72,300, as against 68,700 tons, and copper 157,000, as against 144,000 tons. Despite the growing popularity of radio and wireless, German cable exports are at the rate of 45,000 metric tons yearly.

With regard to aluminum, the only country in Europe where the recent London price reduction of £10 per long ton, by the European Aluminum Cartel, appears to have had any effect in increasing consumption, thus far, seems to be Germany, where aluminum can stand its ground beside copper. A rival of copper and aluminum has appeared in magnesium, or the "Electronmetall" of the I. G. Farbenindustrie. Although the manufacture of this metal from the mineral (carnallite) in Germany is proceeding rapidly, and though the chemical combine has contracted for future requirements at the present price levels, there is a strong belief, in well-informed circles, that within a short time magnesium and associated alloys will be cheap enough to compete largely with aluminum, particularly in the field of automobile and aircraft manufacture, where it is already an important factor. The present price ratio of magnesium to aluminum is around 4.7:1, but of course the greater lightness of the former must be taken into consideration. Also, in England the British Maxium Company and the French subsidiaries are forging ahead in magnesium manufacture. In Italy the automobile firm Isotta Fraschini is a large consumer of the electron metal, as it is locally called.

The mining company of Gundafa, which produces zinc and lead ores from mines in the south of Marrakes (Morokko), has made contracts with the Penarroya and with the Compagnie Franco-Américaine des Métaux et Minérais whereby its entire production will be sold to those firms.

Concerning the new Russian zinc smelter, news has been received here to the effect that it will be erected near Bjelowo and on a site adjoining the railway which connects Kusnezk with the main line of the Trans-Siberian Railroad. The mines were formerly operated by the Russo-Asiatic Consolidated, Ltd. They are in the Ural and Western Siberian Mountains and are known to contain gold and silver as well as zinc, all of which will be recovered at the new smelter. The announced sum of 16,000,000 rubles to be spent by the Russian authorities for this installation appears unduly large, but costs may be reduced through the efforts of German engineers, who are expected to cooperate in the design and construction of the new plant.

STATISTICAL NOTES

Granby Consolidated M. S. & P. Co., Ltd., reports the results of operations for the second quarter of 1928, in comparison with results secured in the first quarter, in the following tabulation:

Production and Costs

	1928 First Quarter	1928 Second Quarter
Copper produced, pounds	13,561,345	14,512,955
Average cost per pound, in cents	9.654	8.867

Cost figures include all charges except those for depreciation and depletion. Returns from precious metals have not been credited to cost of copper.

Profit-and-Loss Statement

	1928 First Quarter	1928 Second Quarter
Operating income	$501,996	$693,953
Miscellaneous income	60,641	56,644
Total income	$562,638	$750,597
Less bond interest	9,032	2,988
Net income (before depreciation or depletion)	$553,606	$747,609

The net income is principally from the Anyox properties. Earnings at Allenby were appreciably reduced because of the refractory character of the ore, abnormally high smelting and refining charges, and the long overland haul of finished copper to market.

Compagnie Aramayo de Mines en Bolivia, producer of tin, copper and bismuth, reports the following results from its operation in 1927: Operating profit for the year amounted to £277,295, which compares with $279,561 in 1926. A total of 49,271 tons of ore, assaying 5.21 per cent tin and 48.4 oz. silver, was mined and milled in 1927, compared with 38,716 tons of ore, analyzing 5.81 per cent tin and 58.7 oz. silver per ton, in 1926. Ore reserves on Dec. 31, 1927, totaled 317,720 tons, assaying 4.43 per cent tin and 50.4 oz. silver per ton. On Dec. 31, 1926, ore reserves were 281,638 tons of 4.83 per cent tin ore carrying 78.4 oz. silver per ton. Production of metallic bismuth in bars, residues, and export ores was 68.31 tons, against 133.31 tons in 1926.

Howe Sound Company, operating the Britannica mine, in British Columbia, and the Calera and El Potosi mines, in Mexico, compares its metal production for the first two quarters of 1928, as shown in the following table:

	Second Quarter	First Quarter
Gold, oz.	4,580	3,050
Silver, oz.	845,042	882,151
Copper, lb.	11,703,480	9,438,600
Lead, lb.	18,973,044	19,560,036
Zinc, lb.	14,941,531	14,260,462

Net income for the second quarter was $667,165, against $559,196 in the first quarter of 1928.

MARKET COMMENT

A New Era in Copper Selling

FOR years now, those who have had charge of the selling of copper have been the object of frequent scornful jibes belittling the intelligence with which they conducted their business. These were not altogether undeserved, for the copper market, until recently, was handled something after the following fashion: There is a good buying wave in progress in which sellers A, B, C, D, E, F, G and H participate. They all sell freely at 14c. until C sells out his production and raises his price to 14⅛c. to keep out further business. A, D, E, G and H then find themselves pretty well sold out, too, making a similar advance, but B and F, not having had quite their share of the business, think the advance is not justified, and continue at 14c. for a day or two, being swamped with orders; so they come up to 14¼c., believing a tremendous buying wave on. The others, finding that they had been ultra conservative in estimating their supplies, sell another good tonnage in the next few days, gradually coming to 14¼c., like B and F, as their supplies run out. Finally, after selling 100,000 tons all are at 14¼c., and the brass, wire and sheet copper manufacturers revise their prices upward to a 14¼c. copper basis. By this time, every consumer has bought what he thinks he will need for at least two months ahead, and some for three. At least one buyer, with fear in his heart, has bought a part of his requirements for nine months ahead. Thus satiated, no interest whatever is taken in the market for the next three weeks, all sellers quoting 14¼c. But B and F, desiring to avoid all speculation, have a policy of selling their intake, largely from week to week, and soon they have some copper to market or possibly one of their clients is an anxious seller at just this time. Perhaps 1,000 tons is offered; the best price obtainable is 14⅛c., the buyer taking the lot because it is a bargain. But F is also getting uneasy with a couple of thousand tons to sell before Saturday. *E. & M. J.* has quoted the 14¼c. price for Wednesday, but a further concession to 14c. is now necessary, it being the dark of the moon, with all the bears out. All the other producers are very righteously at 14¼c., but along comes a favorite customer of A for a car of billets. He would feel very much wronged if he did not get them on the ruling basis of 14c. It being only a carload, the seller makes the concession, as do C and D, on similar small special business. In another three weeks B and F, now joined by their lesser brothers, G and H, after urgently chasing customers for a few thousand tons, have been compelled to cut down to 13¾c. to market their copper. In fact H, after listening to three bearish stories from consumers within an hour, sells 500 tons at 13⅞c. Another week or two goes by without further concessions, when, all of a sudden, consumers cannot postpone buying longer and inquire for appreciable tonnages. A and C are so overjoyed at the opportunity of selling two 3,000-ton lots that they meet the 13¾c. market, in two very secretive sales, not knowing that manufacturers are way underbought. Further incentive to coming to this price has been given by reports from Consumer X that D would also sell at 13¾c. They, and D also, begin to feel that it is only just to the consumer to sell at the market—13¾c.—rather than hold at their nominal price of 14c., and the buying wave begins all over again, ¼c. lower than before, if the sellers are not too unlucky.

But several manufacturers are caught with too limited supplies. Every one wants prompt copper. In the rush a big refining furnace runs amuck, a tidal wave sweeps up the Hudson, delaying if not sinking the Rome consignments, and a storm ties up the New Haven for three days. The consumers find that there is not as much prompt copper as they thought and they have to slow up their operations; the producers find that the consumers are not as well supplied as they thought, but they can't do anything about it. And they have been cutting prices too. And in the meantime Mr. A has had lunch with Mr. D, and both have had lunch with Mr. Consumer X, and the lie, direct and indirect, is freely passed, and hard feelings are cultivated by all. Great grief! That was in the old days.

Can it be that we are now entering a new era? Since May 25 the price of copper has been 14¾c. in the East and 14⅞c. in the consuming points to the West, and 15c. abroad. Not since the war has the price been so stable. Sales are beginning to be pretty good each week. Constant dickering about price has been avoided. In the week when 15,000 tons was sold no attempt was made to increase the price, nor was any decrease noted when only 3,000 tons was sold. No kick has been heard from any factor, producer, manufacturer, or ultimate consumer. If the present price is sufficiently attractive to bring out more permanent additional production from marginal producers than the consumptive requirements demand, it seems likely that the price will be reduced, with a thorough understanding of the situation, and an aversion to a permanent and continuing increase in stocks. If requirements are greater than production is meeting, at current rates, a little higher price will be quoted, to encourage more production. What could be saner?

Canadian Platinum-Group Production Increased By 3,287 Oz. in 1927

PLATINUM-GROUP metals statistics, as reported by the Dominion Bureau of Statistics at Ottawa, show that 11,228 oz. of platinum, valued at $717,613, was produced in 1927, against 9,521 oz. valued at $923,607, in 1926; and 11,545 oz. of palladium, rhodium, and iridium, valued at $554,190, against 10,024 oz. valued at $640,178, in 1926. Imports of platinum were valued at $130,020 in 1927, compared with $187,421 in 1926. This material was all in manufactured form. During the year 771 oz. of platinum in concentrates and 221 oz. of scrap, a total of 992 oz., valued at $68,449, was exported, against 916 oz., valued at $94,932, in 1926.

Canada stands third in the world's production of platinum, larger amounts coming from Russia and Colombia, South America. In British Columbia small quantities are found in placer deposits with alluvial gold and black sands along sections of the Tulameen and Similkameen rivers. In Ontario these rare metals occur with the nickel-copper sulphide ores produced in the Sudbury district.

Copper-nickel matte containing the precious metals is made at Coniston by the Mond Nickel Company, Ltd., and at Copper Cliff by the International Nickel Company, Ltd. The Mond matte is shipped to Clydach, Wales, for refining. International Nickel Company's matte is shipped either to the United States for the manufacture of monel metal, or to Port Colborne, Ontario, for refining.

Canada's Production of Platinum-Group Metals, 1926 and 1927

	1926		1927	
	Platinum	Palladium, Rhodium, Iridium	Platinum	Palladium, Rhodium, Iridium
Produced by Canadian, United States and British refineries from Canadian mattes and residues, oz.	9,471	10,024	11,217	11,545
Value	$919,349	$640,178	$716,653	$554,190
British Columbia placers, oz.	50	.....	11	.....
Value	$4,258	.....	$960	.....
Totals, oz.	9,521	10,024	11,228	11,545
Value	$923,607	$640,178	$717,613	$554,190

Imports Into Canada and Exports of Platinum, 1926 and 1927

	1926		1927	
	Quantity Ounces	Value	Quantity Ounces	Value
Imports				
Platinum retorts	....	$40,028	....	$26,901
Platinum wire, and in bars and strips	....	138,433	....	94,538
Platinum crucibles	....	8,960	....	8,581
Totals	....	$187,421	....	$130,020
Exports				
Contained in concentrates	520	54,747	771	52,660
Platinum, old and scrap	396	40,185	221	15,789
Totals	916	$94,932	992	$68,449

The Market Report

Copper Demand Features Metal Markets—Lead Moderately Active; Prices Steady

New York, Aug. 15—With copper sales in better-than-average volume, a moderately active demand for lead, and prices steady for other metals, the non-ferrous metal market situation may justly be considered as quite satisfactory. Prices, in general, continue firm, as in recent weeks.

Copper More Active

Last Thursday, the opening day of the current *E. & M. J.* week, saw a large volume of copper contracted for by large and small consumers alike. Cable manufacturers were particularly prominent in the market. Since then, buying has moderated, though the aggregate for the week is well above normal. Most of the business has been for September delivery. Price is unchanged on the basis of 14.75c. per pound, delivered Connecticut Valley. A number of sales have been reported in the Middle West at slight premiums, but they are offset by sales in the immediate vicinity of refineries at small concessions. July copper statistics released yesterday are considered unusually favorable by producers. Stocks of refined copper declined to 54,871 tons on July 31, equivalent to less than twelve days' supply at the current rate of foreign and domestic deliveries. This condition may justly be described as within the danger zone. Production for July was fairly well maintained at the higher level of recent months, but in this connection it is well to note that for the first seven months of 1928 monthly production of American refineries averaged about 4,000 tons per month higher than for the corresponding period in 1927, while domestic and foreign deliveries for the first seven months of 1928 exceed those of the corresponding period of 1927 by more than 12,000 tons per month. Copper Exporters, Inc., maintain their price at 15c. per pound, c.i.f. usual European destinations.

Daily Prices of Metals

Aug.	Electrolytic Copper	Straits Tin	Lead		Zinc
	Refinery	New York	New York	St. Louis	St. Louis
9	14.525	48.75	6.20	5.975@6.00	6.25
10	14.50@14.525	48.75	6.20	6.00	6.25
11	14.525	48.75	6.20	6.00	6.25
13	14.50 @14.55	48.25	6.20	6.00	6.25
14	14.525@14.55	48.25	6.20	5.975@6.00	6.25
15	14.525@14.55	48.125	6.20	6.00	6.25
	14.527	48.479	6.200	5.996	6.250

Average prices for calendar week ending August 11, 1928, are: Copper, 14.523; Straits tin, 48.396; N. Y. lead, 6.200; St. Louis lead, 5.998; zinc, 6.250; and silver, 58.979.

The above quotations are our appraisal of the major markets for domestic consumption based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

Copper, lead, and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

In the trade, copper prices usually are quoted on a delivered basis: that is, delivered at consumer's plant. As delivery and interest charges vary with the destination, the figures shown above are net prices at refineries on the Atlantic seaboard. Delivered prices in New England average 0.225c. per pound above those quoted, and prices at so-called Middle West destinations, 0.325c. above.

Quotations for copper are for the ordinary form of wire bars and ingot bars. For ingots an extra 0.05c. per pound is charged; for slabs, 0.075c.; and for cakes, 0.125c. up, depending on weight. Cathodes are sold at a discount of 0.125c. per pound.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York is now quoted at 0.35c. per pound above St. Louis, this being the freight rate between the two points.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

London

Aug.	Copper			Tin		Lead		Zinc	
	Standard		Electrolytic						
	Spot	3M		Spot	3M	Spot	3M	Spot	3M
9	62 3/8	62 7/8	68 3/4	215 1/4	212 1/2	21 1/4	21 1/4	24 7/16	24 11/16
10	62 3/8	62 7/8	68 3/4	215 3/4	213	21 1/4	21 5/16	24 3/8	24 5/8
13	62 3/8	62 7/8	68 3/4	213 1/2	211 3/4	21 3/8	21 1/2	24 3/8	24 5/8
14	62 7/16	62 7/8	68 3/4	212 3/8	210 5/8	21 11/16	21 11/16	24 7/16	24 3/4
15	62 3/8	62 7/8	68 3/4	213 1/2	210 1/4	21 11/16	21 11/16	24 5/8	24 13/16

The above table gives the closing quotations on the London Metal Exchange. All prices in pounds sterling per ton of 2,240 lb.

Silver, Gold, and Sterling Exchange

Aug.	Sterling Exchange "Checks"	Silver		Gold London	Aug.	Sterling Exchange "Checks"	Silver		Gold London
		New York	London				New York	London	
9	4.85	59 1/4	27 5/16	84s11 1/2d	13	4.85	59	27 1/4	84s11 1/2d
10	4.85 1/16	59 1/8	27 1/4	84s11 1/2d	14	4.85	58 7/8	27 3/16	84s10 3/4d
11	4.85 1/16	59	27 1/4	.....	15	4.84 7/8	58 7/8	27 1/8	84s11 1/2d
						Avg.	59.021		

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of bar silver, 999 fine. London silver quotations are in pense per troy ounce of sterling silver, 925 fine. Sterling quoations represent the demand market in the forenoon. Cables command three-eighths cent premium.

Better Feeling in Lead Market

An advance of 12s. 6d. during the week in the London price for spot lead has been a factor in improving sentiment in the domestic market. It is reported that consumers on the Continent have been buying in somewhat greater quantity than heretofore, and a bullish attitude on the part of British dealers has helped advance the price. In the aggregate, business in the domestic market during the week ending today has been close to average, although one of the important factors has found inquiry unusually quiet. The price in New York is well maintained at 6.20c., which is also the contract price of American Smelting & Refining. In the St. Louis market some small lots, and one fairly substantial shipment, changed hands at 5.975c., but the bulk of a good turnover brought 6c. Prompt and August delivery predominated, especially for smaller lots; whereas several sales for round tonnages were for September. Two or three of the largest domestic consumers have been in the market for additional tonnages of spot metal, suggesting that their requirements for the current month are somewhat larger than they had foreseen. It is altogether likely that consumers by and large are underbought, and something of a "buying wave" is looked for within the next few weeks. Among the buyers are to be noted cable interests and paint manufacturers. One maker of storage batteries is among the consumers who bought spot.

Statistics for July, just issued, show a small decline in the rate of production in the United States and Mexico and a reduction of 1,500 tons in refined stocks. This showing is somewhat

better from the standpoint of producers than many had expected, and is of course an element in the better feeling toward the market.

Zinc Market Quiet but Prices Firm

Sales of zinc have been in small volume during the week ending today, but price remains at 6.25c. per pound. Statistics, showing a further decline in stocks for July, reflect the present favorable position of the zinc producers. August and September delivery has been specified on the larger portion of the tonnage, but some October and November metal has been contracted for.

The June statistics of the American Zinc Institute follow, the figures being in tons of 2,000 lb.:

Stock, July 1	44,468
Produced	50,890
Shipped	53,148
Stock, July 31	42,210
Shipped from plants for export	3,638
Metal sold, not yet delivered, July 31	16,986
Total retort capacity, July 31	115,720
Average number of retorts operating in July	65,864
Number of retorts operating, July 31	62,384

These statistics indicate the improvement in the zinc situation.

Fair Demand for Prompt Tin

With consumers displaying a modest appetite for prompt tin, and with the domestic supply rather closely held, fair premiums are being obtained for early delivery. Futures do not interest buyers particularly, and can be had at 1½c. below the market for spot metal. Speculative support continues in evidence in the London market, but most interests are inclined to foresee a downward reaction before long.

Silver Dull but Steady

During the last week the silver market was again dull and featureless. India has shown some interest as a small buyer and China has operated both ways. The undertone appears steady.

Mexican Dollars (old Mexican pesos): Aug. 9th, 44⅜c.; 10th, 44⅝c.; 11th and 13th, 44½c.; 14th and 15th, 44⅜c.

Foreign Exchange

Some of the foreign exchanges, including sterling, have eased fractionally during the past week. Closing cable quotations on Tuesday, Aug. 14, were as follows: Francs, 3.90½c.; lire, 5.23c.; and marks, 23.81½c. Canadian dollars, ⅛ of 1 per cent discount.

Other Metals

Quotations cover large wholesale lots unless otherwise specified.

ALUMINUM—Per lb., 99 per cent plus grades, price of leading interest, 24.30c. Outside market, 99 per cent plus, 24.30c.; 98-99 per cent, 23.90c.

ANTIMONY—Per lb., duty paid, New York; Chinese brands, for all positions 10@10½c. Cookson's "C" grade, spot, 15⅜c.

BISMUTH—Per lb., New York, in ton lots, $1.70. Smaller lots, $1.85 and up.

CADMIUM—Per lb., New York: 70 @75c., according to quantity.

IRIDIUM — Per oz., $280@$300 for 98@99 per cent sponge and powder. Market dull.

NICKEL—Per lb. ingot, 35c.; shot, 36c.; electrolytic, 37c. (99.9 per cent grade) for single lots of spot metal.

PALLADIUM — Per oz., $42@$47. Small lots bring up to $50. Market very dull.

PLATINUM—Official price quoted by the leading interest on small miscellaneous orders for refined metal, per oz., $78. Dealers and refiners quote the trade for refined metal, per oz., cash, for wholesale lots, $74@$74.50 bid, $75.50@ $76.50 asked. Nominal.

QUICKSILVER — Per 76-lb. flask, range for the week $122.50@$125, depending on quantity. Some improvement in consumer buying. San Francisco wires $123.67.

Prices of Cobalt, Germanium Oxide, Lithium, Magnesium, Molybdenum, Osmium, Radium, Rhodium, Ruthenium, Selenium, Tantalum, Tellurium, Thallium, Tungsten, and Zirconium are unchanged from the issue of Aug. 4.

Metallic Ores

MANGANESE ORE—Per long ton unit of Mn, c.i.f. North Atlantic ports, minimum 47 per cent Mn: 35@38c. Caucasian, washed, 53@55 per cent, 38@ 40c. Chemical grades unchanged from quotations in the Aug. 4 issue.

TUNGSTEN ORE—Per unit of WO_3, N. Y.; Wolframite, $10.75@$11, Western scheelite, $10.75@$11.

Chrome, Iron, Tantalum, and Titanium ores are unchanged from quotations in the Aug. 4 issue.

Car Shortage Cuts Down Joplin Ore Shipments

Joplin, Mo., Aug. 11, 1928.

Blende	Per Ton
High	$42.45
Premium blende, basis 60 per cent zinc	$40.00@ 41.00
Prime Western, basis 60 per cent zinc	40.00
Slimes and fines, 60 per cent zinc	37.00@ 39.00
Average settling price, all zinc	39.84
Galena	
High	$81.90
Basis 80 per cent lead	80.00
Average settling price, all lead	81.39

Shipments for the week: Blende, 11,007; lead, 1,613 tons. Value, all ores the week, $569,810.

A shipment of 1,000 tons of zinc ore less than the production this week is credited to the large demand for cars in grain shipments. Smelters are stocked with sufficient supplies or ore, with what shipment it is possible to make, to tide them over until more cars are at their disposal for ore shipments.

Some producers are selling lead ore each week, and a few are holding their ore in reserve.

Platteville, Wis., Aug. 11, 1928.

Zinc Blende	Per Ton
Blende, basis 60 per cent	$42.75
Lead Ore	
Lead, basis 80 per cent	$82.00

Shipments for the week: Blende, 671 tons; lead, 40 tons. Shipments for the year: Blende, 22,729 tons; lead, 1,285 tons. Shipments for the week to separating plans, 1,511 tons blende.

Non-Metallic Minerals

Amblygonite, Asbestos, Barytes, Bauxite, Borax, Celestite, Chalk, China Clay, Diatomite, Emery, Feldspar, Fluorspar, Fuller's Earth, Garnet, Gilsonite, Graphite, Greensand, Gypsum, Iron Oxide, Lepidolite, Limestone, Magnesite, Mica, Monazite, Ocher, Phosphate, Potash, Pumice, Pyrites, Quartz Rock Crystal, Silica, Spodumene, Sulphur, Talc, and Tripoli are unchanged from prices in the Aug. 4 issue.

Metallic Compounds

ARSENIOUS OXIDE (White Arsenic) —Per lb., 4c. Market firm.

Antimony Oxide, Calcium Molybdate, Copper Sulphate, Sodium Sulphate (Salt Cake), Sodium Nitrate, and Zinc Oxide are unchanged from prices in the Aug. 4 issue.

Alloys

FERROMANGANESE—Per long ton, domestic and foreign, f.o.b. furnace or duty paid, port of entry, $105 quoted for last half, 1928. Spiegeleisen, 19@21 per cent, $33 f.o.b. furnace.

FERROTUNGSTEN—Per lb. of W contained, 75@80 per cent, 96@98c. f.o.b. works.

Ferrocerium, Ferrochrome, Ferromolybdenum, Ferrophosphorus, Ferrosilicon, Ferrotitanium, Ferrovanadium, Monel Metal, Nickel Silver and Yellow (Muntz) Metal are unchanged from prices in the Aug. 4 issue.

Rolled Metals

Copper, Lead, and Zinc Sheets are unchanged from prices in the Aug. 4 issue.

Refractories

Chrome Brick, Fireclay Brick, Magnesite Brick, Silica Brick and Zirkite are unchanged from quotations in the issue of Aug. 4.

Iron, Steel, and Coke

Iron—Per gross ton, Valley furnaces, Bessemer, $17; basic, $15.75@$16; No. 2 foundry, $16.50@$16.75.

Steel—Base prices per gross ton, Pittsburgh, billets and slabs, $33; plates, structural shapes, and soft steel bars, per pound, 1.85@1.90c.

Coke—Per gross ton, Connellsville furnace, contract, $2.75@$3; spot, $2.50 @$2.75. Connellsville foundry, contract, $3.50@$4.85; spot, $3.75@$4.50. By-product coke, Ohio and Kentucky, $7; Buffalo and Detroit, $8.50@$9.

Mining Stocks—Week Ended August 11, 1928

Stock	Exch.	High	Low	Last		Last Div.
COPPER						
Anaconda	New York	67⅛	65⅛	65⅛	Jl.14, Au. 20 Q	1.00
Ariz. Com'l	Boston	4¼	4⅛	4⅛	Jl. 16, Jl. 31 SA	0.25
Cal. & Ariz	New York	97⅛	94	94	Je. 8, Je. 25 Q	1.50
Calumet & Hecla	Boston	23½	22⅛	22⅛	Au. 31, Se. 15 Q	0.50
Cerro de Pasco	New York	78½	76	76½	Jl.12, Au. 1 Q	1.25
Chile Copper	New York	44⅛	43⅛	43⅛	Se.15 Se.29 Q	0.62½
Con. Coppermines	N. Y. Curb	11⅛	10⅛	11⅛		
Copper Range	Boston	18	17⅛	17⅛	Mr. 24, Ap. 20 A	1.00
Crystal Copper	Boston Curb	*54	*31	*53		
East Butte	Boston	2⅛	2⅛	2⅛	Dec., 1919	0.50
Granby Consol	New York	54½	52½	53	Jl.13, Au.1 Q	1.00
Greene Cananea	New York	104	99⅛	100	Se. 14, Oc.1 Q	1.00
Howe Sound	New York	57⅛	55¼	56⅛	Je.30, Jl.16, Q	1.00
Inspiration Consol	New York	21⅛	20	20⅛	Apr. 1927 Q	0.25
Isle Royale	Boston	19⅛	18	18	Au.31, Se.15 SAX	0.75
Kennecott	New York	96⅛	93⅛	94	Jl. 1, Jl. 2 Q	1.25
Magma Copper	New York	52⅛	49⅛	50	Jl.29, Jl.16 Q	0.75
Mason Valley	N. Y. Curb	1⅛	1⅛	1⅛		
Miami Copper	New York	20⅛	19¼	20¼	Au.1, Au.15, Q	0.37½
Mohawk	Boston	58	56	56	Jl. 31, Se. 1 Q	1.00
Montana-Idaho	Spokane	*19	*16	*16		
Mother Lode Coal	New York	2⅛	2⅛	2⅛	Je.8, Je. 30, SA	0.15
Nevada Consol	New York	23	22⅛	22⅛	Je.15, Je.30 Q	0.375
New Cornelia	Boston	...	...	27⅛	Au.3, Au. 20 Q	0.50
Noranda	N. Y. Curb	50⅛	50⅛	50⅛		
North Butte	Boston	3⅛	3⅛	3⅛	Oct., 1918	0.25
Ohio Copper	N. Y. Curb	*75	*69	*74	Sept., 1926	0.03
Old Dominion	Boston	14⅛	14	14	Dec., 1918	1.00
Phelps Dodge	N. Y. Curb	136	133	134	Je.25, Jl.22 Q	2.00
Quincy	Boston	38⅛	35	35⅛	March, 1920	1.00
St. Mary's Min. Ld	Boston	28	27½	27½	Ap.1928 A	2.00
Seneca Copper	New York	2⅛	2⅛	2⅛		
Shattuck-Denn	N. Y. Curb	18⅛	15⅛	18		
Tenn. C. & C	New York	15⅛	14⅛	14⅛	My.29, Je.15,Q	0.12½
United Verde Ex	N. Y. Curb	15⅛	14⅛	14⅛	July 6, Q	0.50
Utah Copper	New York	165	165	165	Je.15, Je.30 Q	1.50
Utah Metal & T	Boston	1⅛	1⅛	1⅛	Dec., 1917	0.30
Walker Mining	Salt Lake	1.27	1.20	1.20		
NICKEL-COPPER						
Internat. Nickel	New York	103⅛	95⅛	96⅛	Je.14, Je.30 Q	0.50
Internat. Nickel pfd	New York	119	118	118⅛	Jl.12, Au.1 Q	1.50
LEAD						
Gladstone Mtn	Spokane	*3	*2⅛	*2⅛	June, 1927	0.005
National Lead	New York	120⅛	120⅛	120⅛	Se.14, Se.29 Q	1.25
National Lead, pfd. A	New York	144⅛	144⅛	144⅛	Au.31, Se.15 Q	1.75
National Lead, pfd. B	New York	...	...	122	Oc. 19, No.1 Q	1.50
St. Joseph Lead	New York	41	39⅛	39⅛	Je.9, Je.20, QX	0.75
ZINC						
Am. Z. L. & S.	New York	23⅛	25⅛	26⅛	May, 1917	1.00
Am. Z. L. & S. pfd	New York	87⅛	84⅛	85⅛	Nov., 1920	1.50
Butte C. & Z	New York	7⅛	7	7⅛	De., 1926	0.50
Butte & Superior	New York	10⅛	8⅛	9	Je.15,Je.30 Q	0.50
Callahan Zn-Ld	New York	2⅛	2⅛	2⅛	De., 1920	0.50
Consol.Lead&Zinc 'A'	St. Louis	12⅛	12	12⅛	Je.25, Jl.1 Q	0.25
Eagle-Picher	Cincinnati	...	...	17⅛	No.15, De.1 Q	0.40
Eagle-Picher pfd	Cincinnati	...	...	100	July 15 Q	1.50
New Jersey Zn	N. Y. Curb	224	221	224	Jl. 20, Au. 10 X	2.00
Treadwell-Yukon	Toronto	17	16⅛	16⅛		
United Zinc	N. Y. Curb	...	...	*70		
Yellow Pine	Los Angeles	...	...	*25	Dec., 1925 QX	0.04
GOLD						
Alaska Juneau	New York	4	3⅛	3⅛		
Ankerite	Toronto	...	...	*40		
Barry-Hollinger	Toronto	*40	*35	*38		
Central Manitoba	Toronto	*96	*82	*82		
Cresson Consol. G	N. Y. Curb	*99	*76	*95	Je.30, Jl.10 Q	0.10
Dome Mines	New York	8⅛	8	8	Je.30, Jl.20 Q	0.25
Golden Cycle	Colo.Springs	†1.69	†1.68	...	My. 31, Je.10 Q	0.04
Gold Hill	Toronto	*9	*7⅛	*7⅛		
Hollinger Consol	Toronto	9.30	8.50	9.25	Jl.25, Au.11 FW	0.10
Homestake Mining	New York	72⅛	72⅛	72⅛	Au.20, Au.25 M	0.50
Kirkland Lake	Toronto	1.57	1.46	1.48		
Lake Shore	Toronto	21.50	21.00	21.20	Je.1, Je.15 QX	0.20
McIntyre Porcupine	New York	22	21⅛	22	Au.1, Se.1 Q	0.25
Portland	Colo.Springs	†*21	†*19	...	Ap., 1927	0.02
Rand Mines	New York	...	...	39⅛	Fe.21-28 Am.Sh.	1.52
Sylvanite	Toronto	2.40	2.24	2.30		
Teck-Hughes	Toronto	9.40	9.00	9.10	Jl. 17, Au. 1 SAX	0.15
Tom Reed	Los Angeles	*60	*42	*60	Dec., 1926	0.02
Tough-Oakes	Toronto	*25	*19	*20⅛		
Vipond Cons	Toronto	*43⅛	*39	*42⅛	April, 1927	0.03
Wright-Hargreaves	Toronto	3.35	3.15	3.24	Jl.16, Au.1 Q	0.02½
GOLD AND SILVER						
Carnegie Metals	N. Y. Curb	18⅛	17⅛	17⅛		
Con. Cortez	N. Y. Curb	*25	*25	*25		
Dolores Esperanza	N. Y. Curb	1⅛	*80	1⅛	July, 1923	0.05
N.Y. Hond's Rosario	N. Y. Curb	...	...	15	Jl.18, Jl.28 Q	0.50
Premier Gold	N. Y. Curb	2⅛	2⅛	2⅛	Je.14, Jl.3 Q	0.06
Tonopah Belmont	N. Y. Curb	...	...	1	Oc., 1925	0.05
Tonopah Extension	N. Y. Curb	*13	*13	*13	Ap., 1925	0.05
Tonopah Mining	N. Y. Curb	4⅛	4⅛	4⅛	Mar.31,Ap.21 SA	0.07½
West End Consol	N. Y. Curb	...	...	*5	Mar., 1923	0.05
Yukon Gold	Boston Curb	*74	*73	*74	June, 1918	0.02
SILVER						
Beaver Consol	Toronto	*88	*88	*88	May, 1920	0.03
Castle-Trethewey	Toronto	*48	*40	*45		
Coniagas	Toronto	4.35	4.10	4.10	May, 1924	0.12½
Keeley	Toronto	*51⅛	*48	*50	Mr.1, Mr.15 SA	0.04
Lorrain Trout Lake	Toronto	...	...	*50	July, 1925	0.05
Mining Corp. Can	Toronto	3.35	3.05	3.15	My.20, Je.13 SA	0.125
Nipissing	N. Y. Curb	3⅛	3⅛	3⅛	Je.30, Jl.20Q	0.075

Stock	Exch.	High	Low	Last		Last Div.
SILVER-LEAD						
Ahumada	New York	3⅛	2⅛	2⅛	Ap., 1927	0.12½
Bingham Mines	Boston	46	44	44	Jl.31, Au.4 Q	1.00
Bunker Hill & Sullivan	N. Y. Curb	130	125⅛	125⅛	Jl.31, Au.4 MX	0.75
Cardiff M. & M	Salt Lake	*55	*50	*50	Feb. 5, 1927	0.10
Chief Consol	Salt Lake	3.90	3.30	3.35	Ja.10, Fe.1 K	0.10
Consti'nMng.&Mill'g.	Spokane	*25	*15	*30		
Eruption	Boston Curb	*25	*18	*20	Dec. 13, Jan. 3,	0.07½
Eureka Lily	Salt Lake	2.00	1.67½	1.67½		
Federal M. & S	New York	...	...	125	Je., 1927	10.00
Federal M. & S. pfd	New York	98	98	98	Au.15, Se.15 Q	1.75
Hecla Mining	N. Y. Curb	...	...	15	Au.15, Se. 1 Q	0.15
Highland-Surprise	Spokane	*12⅛	*11	*11		
Iron King Mining	Salt Lake	*92	*75	*78		
Keystone Mining	Salt Lake	†*27	†*23	...	Fe., 1926	0.07½
Lucky Jim	Spokane	*31	*29	*29		
Lucky Tiger-Com	Kansas City	†7.40	†7.15	...	Au.7,Au.20 M	0.05
Mammoth Mining	Salt Lake	1.40	1.40	1.40	De., 1926	0.25
North Lily	Salt Lake	7.80	7.70	7.70		
Park Utah	New York	10⅛	9⅞	9⅞	Je.15, Jl.2 Q	0.20
Plutus Mining	Salt Lake	1.50	1.50	1.50	Ap.10, Ap.16 Q	0.10
Rico-Argentine	Salt Lake	*48⅛	*45	*45	June 15 Q	0.03
Silver King Coal	Salt Lake	12⅛	12⅛	12⅛	Je.20, Jl.2 Q	0.25
Silversmith	Spokane	*11⅛	*9	*10⅛	Oct., 1926 Q	0.02
Strattons Mines	Spokane	*97⅛	*85	*95		
Sunshine M. Co	Spokane	1.35	1.30	1.33	June 20, K	0.02
Tamarack-Custer	Spokane	*45	*42	*44⅛	Sept., 1924	0.25
Tintic Standard	Salt Lake	14	13⅛	13⅛	Je.18, Je.30 QX	0.30
Utah-Apex	Boston	3⅛	3⅛	3⅛	Jl.14, Au.1 K	0.25
IRON						
Bethlehem Steel	New York	58⅛	55⅛	58	Jl., 1924	1.25
Cleveland-Cliffs Iron	Cleveland	106	106	106	Jl.14, Jl.25, Q	1.00
Colorado F & I, pfd	New York	64⅛	58⅛	59	Au.10, Au.25 Q	2.00
Gt. North'n Iron Ore	New York	21⅛	20⅛	21	Ap. 9, Ap. 30 K	0.75
Inland Steel	New York	57⅛	56	57⅛	Au. 15, Se.1 Q	0.62½
Republic I. & S	New York	63⅛	57	63	Au. 14, Se. 1 Q	1.00
Republic I. & S. pfd	New York	107⅛	107⅛	107⅛	Se. 15, Oc. 1 Q	1.75
Sloss-Sheffield S. & I	New York	...	...	111	Je.9, Je.20 Q	1.50
Sloss-Snef. S.&I. pfd	New York	110	110	110	Je. 20, Jl. 2 Q	1.75
U. S. Steel	New York	143⅛	139⅛	142⅞	Au.30, Se.29 Q	1.75
U. S. Steel, pfd	New York	140⅛	138⅛	139⅛	Au. 6, Au. 30 Q	1.75
Virginia I. C. & C	New York	...	...	14⅛	Jan., 1924	1.50
Virginia I.C.&C. pfd	New York	50	50	50	Je. 16, Jl. 2 SA	2.50
DIAMONDS, PLATINUM, ALUMINUM, VANADIUM, TIN						
De Beers Consol	New York	...	...	23⅛	Ju.16, Ju.26 K	0.97
So. Am. G. & P	N. Y. Curb	3	3	3		
Alum. Co. of Amer	N. Y. Curb	143	135	143		
Alum. Co. of Amer. pf.	N. Y. Curb	107⅛	107⅛	107⅛	Je. 15, Jl. 1 Q	1.50
Vanadium Corp	New York	75⅛	69⅛	71⅛	Au. 1, Au. 15 Q	0.75
Patino M. & E	New York	35⅛	32⅛	32⅛	April, 1928	4s.
ASBESTOS						
Asbestos Corp	Montreal	28	25	27⅛	Jan., 1926	1.50
Asbestos Corp. pfd	Montreal	90	89	90	Jl. 30, Jl. 16 Q	1.75
SULPHUR						
Freeport Texas	New York	63⅛	60⅛	60⅛	Jl.14,Au.1 QX	1.75
Texas Gulf	New York	70⅛	67⅛	68	Je.1, Je.15 Q	1.00
MINING, SMELTING, REFINING AND GENERAL						
Amer. Metal	New York	48⅛	47⅛	47⅛	Au. 21, Se 1 Q	0.75
Amer. Metal, pfd. 6%	New York	110	109	110	Au.15, Se.1 Q	1.50
Amer. Met. pfd 7%..	New York	...	...	125	My.15, Je.1	1.75
Amer. Sm. & Ref	New York	204	196⅛	198	Jl 13, Au.1 Q	2.00
Amer. Sm. & Ref. pfd	New York	135	134⅛	135	Au. 3, Se. 1 Q	1.75
Consol. M. & S	Montreal	248	239⅛	242	Je.30, Jl.16 SAX	6.25
Newmont Mining	N. Y. Curb	162⅛	155⅛	155⅛	Je.30, Jl.16 Q	1.00
U. S. Sm. R. & M	New York	47⅛	46	46	Jl. 5, Jl. 14 Q	0.87½
U.S. Sm. R.&M. pfd	New York	...	...	53⅛	Jl. 5, Jl 14 Q	0.87½

*Cents per share. †Bid or asked. Q, Quarterly. A, Annual. SA, Semi-annually. M, Monthly. FW, four weeks. K, irregular. I, Initial. X, Extra. The first date given is that of the closing of the books; the second that of the payment of the dividend.

Boston quotations courtesy Boston Stock Exchange; Toronto quotations those of the Standard Stock Exchange of Toronto, by courtesy of Arthur E. Moysey & Co.; Spokane, Pohlman Investment Co.; Salt Lake, J. A. Hogle & Co.; Colorado Springs, Colo., Henry Sachs.

LONDON QUOTATIONS—WEEK ENDED July 31, 1928

Name	High	Low	Last	Date	Last Div. Amount
Alaska Mexican ($5)	35/6	35/—	35/—		
Alaska Treadwell ($25)	120/6	120/—	120/—	Nov., 1926	4 (d)
Aramayo Mines (25 frs.)	70/—	62/9	68/9	May, 1928	5 p.c (†)
Burma Corpn. (10 rupees)	14/1½	13/7½	14/—	Aug., 1928	6 annas*
Bwana M'Kubwa (5s)	6/9	5/4½	6 7½		
Camp Bird (2s)	3/7½	3/3	3/4½	April, 1928	16¼ p.c.
El Oro (£1)	4/3	3/9	4/3	Nov., 1924	2½ p.c.*
Frontino & Bolivia (£1)	12/6	11/10½	12/—	July 1928	3¾ p.c.
Mexican Corpn. (£1)	9/6	8/6	9/6		
Mexico Mines of El Oro (£1)	17/6	15/—	17/6	Dec., 1926	3¾ p.c.*
Mond Nickel	83/9	76/3	77/6	Aug., 1928	20 p.c.
N'Changa Copper Mining	19/7½	18/1½	19 6		
Oroville Dredging (£1)	3/10½	3/9	3/9	Dec., 1923	3¾ p.c
Rhodesian Congo Border (£1)	35/—	32/6	33/9		
St. John del Rey (£1)	11/9	11/1½	11/6	April, 1928	7½ p.c
San Francisco Mines (10s)	26/9	26/3	26/9	July 1928	12½ p.c.
Santa Gertrudis (£1)	14/4½	13/9	14/3	July 1928	7½ p.c
Selukwe (2s. 6d.)	11/10½	10/3	10/6	April, 1917	6¼ p.c
S. Amer. Copper (2s.)	2/3	2/—	2/1½	Nov., 1917	75p.c
Tanganyika (£1)	56/—	53/9	55/—	July 1928	5p.c.
Union Miniere de Haut-Katanga (Brussels)	10,400	10,010	0,010	July, 1928	182.60 (‡)

*Free of British income tax. †Swiss francs and plus 15 p. c. bonus. ‡Belgian frs. and free of taxation. §U. S. Dollars.